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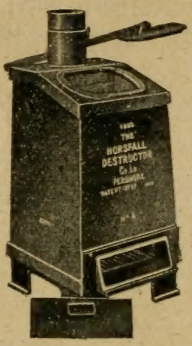

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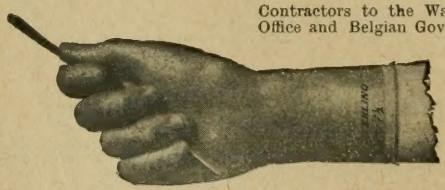

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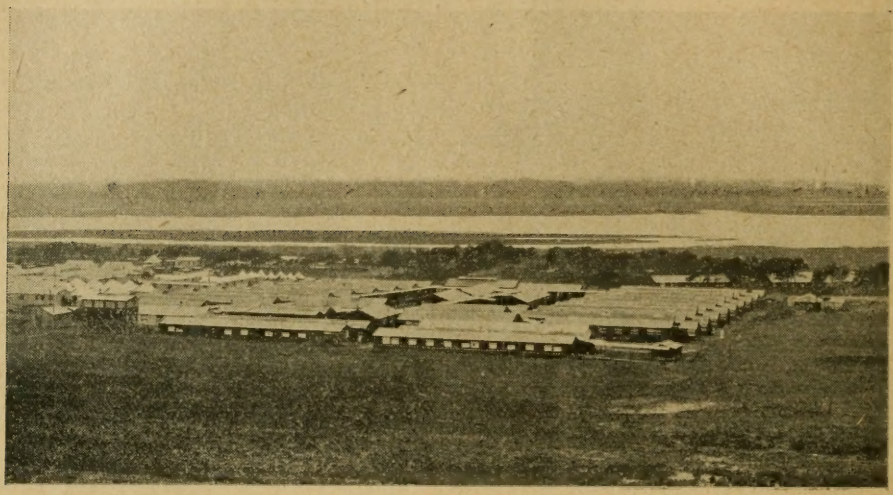

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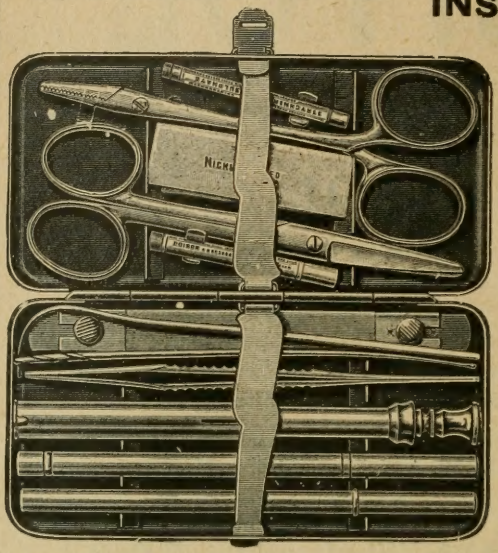

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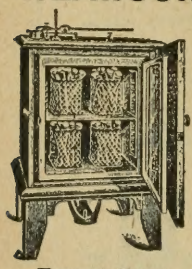

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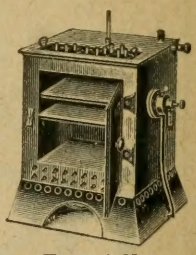

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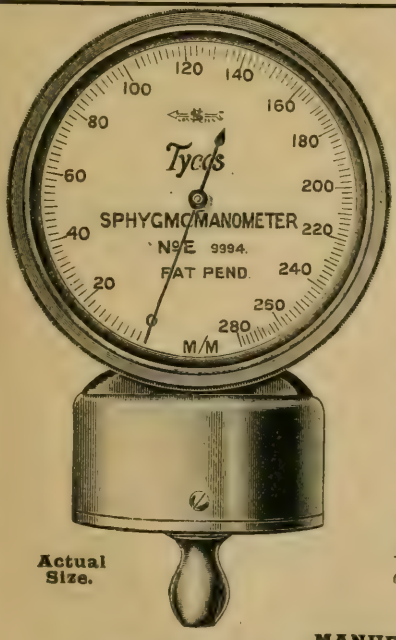

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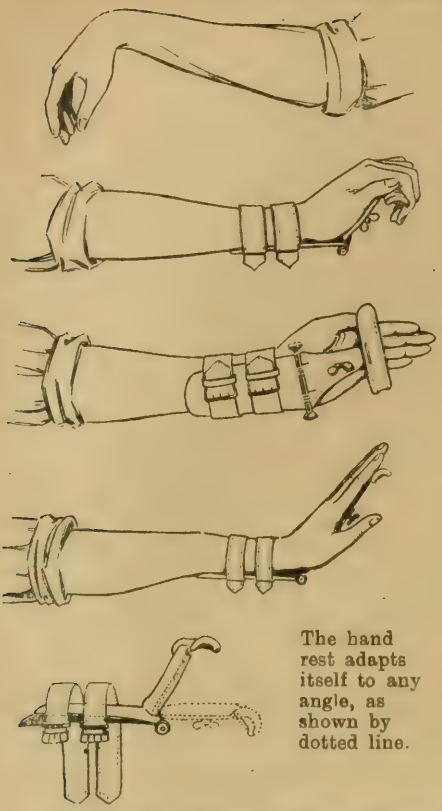

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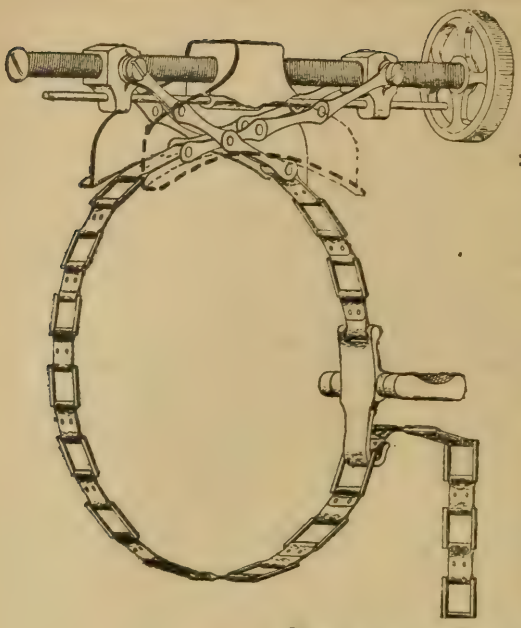

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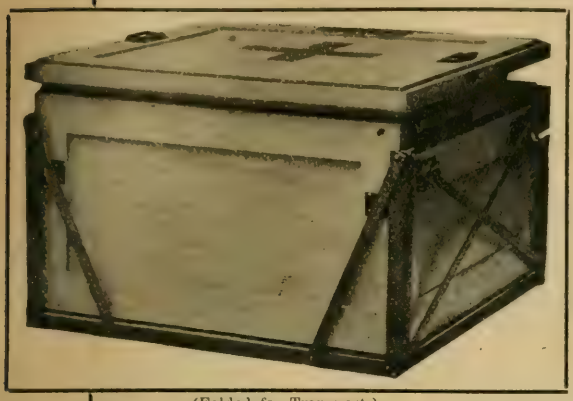

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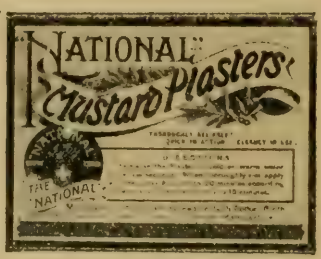

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Original Communications.

A STUDY OF THE MECHANISM OF THE AGGLUTINATION AND ABSORPTION OF AGGLUTININ REACTION, TOGETHER WITH AN EXAMINATION OF THE EFFICACY OF THESE TESTS FOR IDENTIFYING SPECIMENS OF THE MENINGOCOCCUS ISOLATED FROM 354 CASES OF CEREBROSPINAL FEVER.

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Royal Army Medical Corps.
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INTRODUCTION.

AT the present time, owing to the difficulties arising from war conditions, and the stress of work due to the special circumstances in which the study of bacteriology is being prosecuted, we have had in some cases to modify established methods of bacteriological procedure and introduce new technique.

The difficulty of obtaining an adequate supply of pure carbohydrates for performance of sugar tests, and the even greater difficulty of obtaining men trained in laboratory work in bacteriology, has hastened this change in general procedure to a very considerable extent. It is important that the nature—so far as this is susceptible of examination in the present state of our knowledge—and limitations of procedures which have in the past been commonly made use of, or have recently been introduced, be carefully scrutinized.

Such scrutiny would serve the useful purpose of preventing undue enthusiasm for, and its converse, unmerited condemnation of, methods which, when correctly appreciated and properly carried out, afford valuable information.

In the following paper the first three sections are devoted to a

consideration of the mechanism and limitations of the agglutination phenomenon, and of the absorption test. The last section (four) is occupied with an analytical survey of the actual result of application of the agglutination test—checked in a large proportion of the cases by the absorption test—to over 300 specimens of meningococcus isolated from the cerebrospinal fluid of cases and examined at the Central Laboratory, up to the present time.

In order fully to appreciate the potential errors of the agglutination phenomenon, and its amplification, the absorption of agglutinin test, in their application to the identification of micro-organisms, and the establishment of the relationship which they bear to disease processes, it is essential that the factors concerned in the mechanism of these reactions should be borne in mind.

Our knowledge of these reactions has progressed considerably of recent years, and I think that we may fairly state now that the views of Ehrlich, in respect of the phenomenon under consideration, are no longer tenable. The same may be said of the theories advanced by Gruber and Durham, Nicolle, Paltauf, and Dineur, to explain the clumping of micro-organismal suspensions when exposed to the action of corresponding anti-sera.

The view advanced by Bordet that the process of agglutination occurs in two distinct phases, viz.: (1) the union of antigen with antibody; (2) the flocculation of the united antibody antigen "couple" by the electrolytes of the fluid in which the reaction is carried out, has never been controverted, but, on the contrary, has been corroborated by all the experimental work carried out since Bordet's original discovery.

I shall, therefore, discuss the problem of agglutination from the standpoint of Bordet.

In the process of agglutination three separate systems react with one another, the antigen, the antibody and menstruum in which these are suspended; and the reaction is divisible into two phases of:—

(1) Union of antigen with antibody.

(2) Flocculation of the "antibody-antigen complex."

SECTION I.

Points to be noted concerning the Union of Antigen with Antiboby.

(*a*) *Influence of the Reaction of the Menstruum in which the Reagents are suspended.*

Two of the interacting substances, the antigen and the antibody, are, so far as is known, of the nature of complex colloids. The complexity of these colloids is further enhanced by the fact that the active bodies are probably only constituents of still more complex systems. The conditions, therefore, which determine the union or interaction of antibody with antigen are not so far susceptible of complete investigation. Nevertheless,

there is evidence that this union occurs only under certain definable conditions. Thus, in the case of organisms of the colon-typhoid group at least, it will not take place if the fluid be too acid or too alkaline, i.e., the interaction of the two "active" colloids is determined to some extent by the reaction of the menstruum, and it appears to take place most readily when the suspending fluid is isolectric with the mixture of colloids.

The following simple experiments illustrate this point :—

To investigate the action of acid on the process of sensitization a mixture of organisms was suspended in saline with HCl present in a concentration equal to N/100 and sensitized with specific agglutinating serum, titre 1/8000, in concentration of 1/100. The mixture was allowed to stand at room temperature for forty-eight hours ; it was then centrifuged at high speed to deposit the bacteria. The supernatant fluid was drawn off and the deposit washed with distilled water. The material was washed twice in this way and then suspended in distilled water. This suspension was added to a series of tubes containing the following reagents in such concentration that, with the addition of the bacillary emulsion, the concentrations shown in the following table were obtained.

TABLE I.—*B. paratyphosus* B and its Homologous Serum (HCl N/100).

Electrolyte	N/20	N/100	N/1000	N/10000	N/100000
NaCl	—	—	—	—	—
Na_2SO_4 ..	—	—	—	—	—
$BaCl_2$ ..	—	—	—	—	—

Note.—In the above table and in all those which follow :—

\+ = Agglutination.
— = No agglutination.
? = Doubtful result.

The tests were done using macroscopic method, the volume in each tube being 1 c.c. In the experiments with paratyphosus the readings were made after two hours at 37° C. ; with the meningococcus after twenty-four hours at 55° C.

Control experiments with a number of strains of the same and other organisms showed that when sensitization was carried out with sera of much lower titre, 1/2000, in absence of acid the organisms agglutinated readily in all cases at a concentration of NaCl, equal to N/100. The converse of the above experiment using NaOH gave a similar result.

If the reaction of the menstruum then be too acid or too alkaline the union of antigen with antibody is inhibited, and no complex being formed, the system is not susceptible to the flocculating action of electrolytes.

Certain colloidal complexes appear to be more susceptible than others to this disturbing influence, and on this account great care should be taken to prevent the introduction of technical errors.

(*b*) *Influence of the Electrolytes of the Menstruum.*

There is some evidence too (unpublished investigations on biological lysis of red blood cells deprived of their electrolytes by prolonged washing in isotonic sugar solutions) that the formation of an antibody-antigen "couple" is also conditioned by the presence of dissolved salts in the menstruum and that the result obtained depends largely on the nature of the electrolytes in the fluids employed for suspending the reagents. In these experiments it is of course essential that all the fluids used be isotonic with the red blood cells. The "inactive" diluents employed by me in these experiments are solutions of glucose or saccharose.

The work of Pauli (*Zeit. Chem. Ind. Koll.*, 1908, iii, 2) on the relation which the concentration of electrolytes bears to the coagulation temperature of protein points in the same direction, for it will be seen from the second section of the present communication that the behaviour of sensitized organisms—i.e., antibody-antigen "couple"—strongly recalls the reactions of denaturated proteins, and Pauli's investigations indicate that the process of denaturation also is to some extent conditioned by the presence of salts. It is interesting to note that Pauli's work calls attention to the fact that the reaction between salt and protein in this connexion is probably of the nature of a surface condensation.

(*c*) *Influence of the presumably inactive Constituents of the Antigen and Antibody Colloids upon the Process of Sensitization.*

It must be clearly understood that the active substance of (or the peculiarly active physical state of) the serum, or of the organismal colloids, that leads to the initial sensitization in the process of agglutination, does not necessarily include all the constituents of the serum or of the organism.

The (presumably) inactive substances may be present in such quantity or in such a physical state that they protect the united antibody-antigen complex from the flocculating action of electrolytes. I conceive of certain examples of the "negative phase phenomenon" in agglutination as being due to such a mechanism. The following is an example of such a negative phase reaction with the serum of an animal (rabbit) on being immunized with meningococcus, Type III.

TABLE II.—Serum of Rabbit "C" in Course of Immunization.

	$\frac{1}{50}$	$\frac{1}{100}$	$\frac{1}{200}$	$\frac{1}{400}$	$\frac{1}{800}$	$\frac{1}{1600}$
Coccus used for immunization	−	−	+	+	+	Trace

It is to be noted that after being stored for some time this particular serum no longer exhibited a negative phase.

(d) The Quantitative Relationship between Antigen and Antibody in the Process of Agglutination.

The quantitative relationship between antigen and antibody in the process of agglutination is of considerable moment, in view of the fact that upon this directly depends the validity of the absorption of agglutinin test in its application to bacteriological research.

Mainly owing to the work of Eisenberg and Volk, this relationship is now known to obey the same laws as those governing the phenomenon of adsorption or surface condensation.

When a foreign substance is introduced into a two-phase "colloid solution" it tends according to its physico-chemical attributes to distribute itself throughout the system in a peculiar way. Often it will be found to condense itself on the surface of the disperse phase.

For example, if gum arabic be introduced into a tube containing suspended particles of finely divided barium sulphate in water (such a suspension of barium sulphate may be regarded as a suspensoid colloid, admittedly of large particle, dispersed in the water) the gum condenses on the surface of the particles of $BaSO_4$ (barium sulphate), and a complex of "barium sulphate plus gum" is formed. It may be noted in this instance that the gum arabic acts as a protective colloid and inhibits the sedimentation of the $BaSO_4$ due to gravity.

The amount of foreign substance which a disperse phase can adsorb depends, *cæteris paribus*, upon the extent of the surface which it presents for the foreign substance to condense upon.

The law which governs this process is of wide application in physical chemistry and is applicable to the adsorption of hydrogen and other gases by carbon at different pressures, and the adsorption of dissolved substances from various strengths of their aqueous solutions by the same reagent. The law holds good for solutions of any substance in a variety of solvents.

The amount of gas adsorbed, or the quantity of solute removed from a solution by carbon, does not increase either in proportion to the pressure under which the reaction is carried out, in the former instance, or to the concentration of the dissolved substance in solution in the latter. The amount of gas, or material adsorbed from solution, increases much more slowly in proportion than the increase of pressure exerted, or the heightening of concentration of solute in the fluid.

In the agglutination reaction we introduce serum—a foreign substance—into a two-phase system consisting of bacteria dispersed in saline. Such suspensions of bacteria have properties akin to those of non-rigid or emulsoid colloid solutions.

In many respects bacterial suspensions recall solutions of fresh proteins and are flocculated like these by high concentrations of ammonium or magnesium sulphate. Like the proteins too, certain suspensions are flocculated by one concentration of those reagents, while similar

suspensions of other micro-organisms require higher concentrations of these salts to bring this about.

The foreign substance, serum, distributes itself between the saline and the bacteria and, if a sufficiently large bacterial surface *of the requisite character* be available, the whole of the serum will be condensed thereon. If the surface be not sufficiently extended, a certain amount of serum will remain unattached and will be demonstrable in the fluid after removal of the antibody-antigen complex by centrifuging.

The following table from Eisenberg and Volk (*Zeit. Hyg.*, 1902, vol. xl, 155) calls attention to the adherence of this reaction to the law of adsorption, as the figures of Column II are in remarkable agreement with those in Column III, the former of which indicate observed results while the latter give the results as calculated on the general formula of adsorption.

The figures of Column I represent the amount of agglutinating serum, estimated in arbitrary units, exposed to adsorption by a given (arbitrary but constant) quantity of emulsion of the homologous organism. Those of Column II indicate the potency of the demonstrable remaining "agglutinin" observed in the fluid after the serum and organisms have interacted. The potency of the agglutinin is expressed in terms of the same unitage as in the figures of Column I. Column III indicates the potency of agglutinin which should be present after the reaction if the union of antigen and antibody were strictly amenable to the law of adsorption. Column IV indicates the quantity of agglutinin adsorbed, expressed as percentages of the amount exposed to the adsorbing action of the organismal suspension.

TABLE III.

Column I	Column II	Column III	Column IV
Units of agglutinin exposed to absorption	Units observed after absorption	Units which ought to be demonstrable after absorption. Calculated on the "Adsorption Formula"	Units absorbed (observed) expressed as percentage of that exposed to absorption
2	0	0·02	100 per cent
20	0	0·7	100 ,,
40	0	2·1	100 ,,
200	20	19·7	90 ,,
400	60	52·9	85 ,,
2,000	500	478	75 ,,
10,000	3,500	3,890	65 ,,
20,000	9,000	9,160	55 ,,

The above results are so striking that they scarcely call for comment; but the importance of the findings cannot be exaggerated. It is obvious that the absorption of agglutinin test is limited in its application, and that extreme care must be exercised in its technique if reliable results are to be obtained.

Attention is here called to the qualification noted in the previous

paragraph, viz., that the condensing surface must be of the requisite character, that is, that the suspension must be homologous with the serum to be adsorbed.

It is this which introduces that factor in the phenomena of immunology, specificity, concerning which we remain in complete ignorance.

Until the conditions which determine the specificity of serological tests are known, all the so-called immunity reactions must remain fundamentally empirical, so that at present their value as an aid to the further investigation of bacteriological problems can only be gauged by the results obtained.

I might also call attention here to the fact that in addition to the specific adsorption of an antibody to its homologous antigen, there may sometimes be some non-specific condensation of antibody upon heterologous antigen or other disperse phase suspended in the menstruum to which the serum is added. It follows that in carrying out the absorption of agglutinin test one must bear in mind the possibility of thus introducing avoidable error; the test must be performed under such conditions that :—

(*a*) The serum is sufficiently dilute;

(*b*) That the emulsion of organisms is sufficiently dense to bring about complete absorption of specific antibodies, but

(*c*) That the emulsion is not too dense, lest it introduce error owing to aspecific condensation of the serum.

The import of these points will again be noted in considering the practical application of the absorption of agglutinin test, for it will be seen from the later sections of the present communication that it is necessary to elaborate a special technique for every variety of organism, or rather for every group of organisms that one proposes to examine.

(*e*) *Analogies between the Union of Antibody with Antigen and Certain Experiments of Colloidal Chemistry.*

Gengou in an illuminating article (*Arch. Intern. Phys.*, 1908, vol. vii, fasc. 1 and 2), on the subject of molecular adhesion, calls attention to certain important points. He shows, for example, that the apparently different and opposed phenomena of dispersion and agglutination may be due to one and the same mechanism. Those colloids which are in themselves stable bring about dissociation of material suspended in fluids, while unstable colloids added to the same suspension may bring about its flocculation. This point will be further considered in the second part of this article, which deals with the purely physical factor of agglutination—i.e., precipitation.

One point of great import having its counterpart in the phenomenon of agglutination is, that when a colloid is adsorbed to a suspension of, for example, barium sulphate, there results a "$BaSO_4$ colloid complex." If the fluid containing such a complex be centrifuged, it is found that the

deposit obtained consists of the whole complex and not of either constituent alone.

The supernatant fluid is inert and will no longer bring about either dispersion or flocculation, as the case may be, of further quantities of $BaSO_4$ suspension that may subsequently be added to it, provided that the quantity of adsorbable colloid added in the first instance is not too large. The law governing adsorption in general is applicable to these complexes.

An especially interesting point may here be noted, namely, that the complex of a colloid adsorbed to a suspension may have a very different effect upon that suspension than the colloid alone.

Of this phenomenon Gengou also cites an excellent example: Gum arabic added to suspensions of $BaSO_4$ markedly stabilizes these and renders them relatively insusceptible to gravity. On the contrary, the "$BaSO_4$ gum complex," obtained by centrifuging such a mixture, brings about very rapid flocculation of further suspensions of barium sulphate in water subsequently added to it. In the first experiment, sedimentation of the barium is inhibited owing to the particles of that substance being protected one from another by a coating of gum and, as the gum shows no tendency to flocculate, the suspension is stable. In the second experiment, on the contrary, each droplet of gum with its nucleus of $BaSO_4$ forms a particle on the surface of which the $BaSO_4$ which is further added will be adsorbed and condensed.

This second quota of $BaSO_4$ is, however, unprotected, and is therefore liable to flocculate, which it will do all the more rapidly because the particles of the system are much larger and heavier than before, and do not now show the mutual repulsion for one another exhibited by the droplets of gum.

I call attention to these points as they serve to illustrate how apparently paradoxical may be the interaction of relatively simple colloidal systems with one another, and to indicate the paramount necessity for special care being observed when carrying out tests in which the interacting systems appear to be almost infinitely complex, as is the case in the immunity reactions.

(*f*) *Influence of the Physical State of the Reacting Systems upon the Union of Antibody with Antigen.*

In Section I, Subsection (*b*), of the present communication, attention is called to the fact that sensitized organisms—serum-organism "complex"—behave in certain cases as does denaturated protein. It is remarkable that in respect of agglutination, if either of the interacting colloids be denaturated by heat prior to their being mixed together, agglutination may not take place. Indeed, serum exposed to relatively high temperature may even develop inhibitory properties, thus Priestly (*Journ. Hyg.*, 1917, February,

p. 500) finds that if agglutinating sera be heated to certain temperatures, which vary according to the serum under investigation, temperatures between 60° C. and 70° C. for thirty minutes, they may no longer produce agglutination of emulsions of the homologous organism in any dilution; the same serum heated to 75° C. for a similar time may become not only inactive but even inhibitory, and will interfere with the agglutinating power of the (same) unheated serum.

If it be exposed to a still higher temperature it fails to produce agglutination, and further, it loses its inhibitory property.

The same is true to some extent of bacteria. Thus Eisenberg and Volk (*Zeit. f. Hyg.*, vol. xl., 1902) find that bacteria heated above 65° C. may no longer agglutinate in presence of immune serum. This seems to be true of most organisms; it has been my experience with representatives of the colon-typhoid group of bacilli, meningococci and *B. tetani* when heated to 75° to 80° C. for thirty minutes.

I conceive of this alteration in agglutinability as depending upon an alteration in the physical state of the reagents. Its import cannot be overrated, for it implies that there are different optimum conditions for the demonstration of each type of reaction between antibody and antigen, so that here again the essentially empirical nature of the agglutination test is emphasized, until, at least, these optimum conditions have been determined in respect of the particular complex that is under investigation.

What precisely happens on "overheating" an antibody or an antigen it is difficult to say, and in the first instance—overheating of the serum—the problem appears incapable of solution by simple experiment. Michaelis, Eisenberg and Volk, and Bail, have, however, demonstrated that it is the process of flocculation, and not that of the union of antigen with antibody, which is thus inhibited.

In the latter case—"overheating" of the antigen—it seems that the modification of the antigen is such that the complex which it forms with the serum is not susceptible to flocculation by electrolytes. That the anti-bodies of the serum unite with the organisms is shown by the fact that they are removed by absorption with emulsions of "overheated" bacteria.

The following experiment illustrates this phenomenon in the case of the meningococcus.

An emulsion of meningococcus (a Type III coccus was used) standarized to contain 4,000 million cocci per cubic centimetre, was divided into two portions, A and B.

A was exposed to a temperature of 65° C. for thirty minutes, and B to a temperature of 80° C. for the same time.

Each was then used for saturating a specimen of Type III serum, following the standard technique.

The following day agglutination and saturation experiments were set up with A and B, the following results being obtained:—

TABLE IV.

	Unsaturated serum				Saturated serum. Coccus added was heated 30 minutes at 65° C.			
	1/100	1/200	1/300	1/400	1/100	1/200	1/300	1/400
Coccus heated 30 minutes at 65° C. ..	+	+	+	+	−	−	−	−
Coccus heated 30 minutes at 80° C. ..	+	−	−	−	−	−	−	−

Note.—The temperature to which the organism must be exposed and the time during which it is exposed thereto varies considerably. Some emulsions are more susceptible than are others to the influence of heat. This probably depends on the reaction of, and the electrolytes present in, the menstruum. Pauli's work on the coagulation of the proteins would lead one to expect such variation.

The complexity of the whole mechanism is further enhanced by the fact that agglutinogen so called is not a definable substance. All organisms contain—in terms of the nomenclature used by Ehrlich and his followers—more than one agglutinin-producing antigen, as is shown by Joos (*Cent. f. Bakt.*, vol. xxxiii, 1903). This author shows that in the case of *B. typhosus* one of these antigens or a group of them, is thermostable and another, or others, thermolabile. Even more important than the finding of Joos are those of Scheller (*Cent. f. Bakt.*, vol. xxxvi, 1904, and vol. xxxv, 1905) that heated bacteria may absorb agglutinins from the sera with more avidity than do emulsions of the same organisms when they have not been heated.

The influence, then, which previous heating exercises upon organisms that are to be agglutinated is not unimportant. Heating to certain temperatures may enhance both the power which a given suspension of organisms has of combining with antibodies, and the flocculability of the complexes which the organisms form with these, while heating to 80° C., although it does not necessarily inhibit the formation of a "complex," may inhibit flocculation.

The conditions under which such heating, before exposure of the suspension to the agglutinating serum is carried out, are important. A saline suspension heated to 65° C. is agglutinable in the case of most organisms, but a similar suspension heated to 65° C. in saline containing 0·5 per cent pure phenol may not flocculate on exposure to the same serum.

The assumption that there is a multiplicity of agglutinogenic antigens in one organism, as conceived by Joos, renders the whole subject of agglutination unnecessarily complex. If it be true, it is not improbable that the optimum conditions for the flocculation of one particular antigen-antibody complex will differ from the optimum conditions for the flocculation of another, although the two antibodies are each constituents of the same serum, and the two antigens constituents of the same organism.

In another connexion the (assumed) "multiplicity" of so-called agglutinin-producing antigens is of importance, for the more specific response on the part of an animal to inoculation with emulsions of certain organisms occurs more readily than the less specific or group response.

There is really another explanation for this which is dealt with in Part II.

This is particularly true of meningococcus and is to a less extent true of *B. tetanus*. For this reason in working with these organisms I invariably employ only the serum of animals whose course of immunization has not been prolonged beyond ten days.

A similar fact, and one of considerable importance, particularly in the study of the pathogenic anaerobes, is that if an animal be immunized with mixed cultures of certain organisms, the antibodies for one of the organisms comprised in the mixture may be demonstrable in the blood serum of the animal some days before those corresponding to the others are manifest.

It has so far been my experience—although this is admittedly limited—that the response of the animal to the more pathogenic constituent of the mixture occurs earlier and is more easily demonstrable than is the response to the less pathogenic constituent.

SECTION II.

The Second Phase of Agglutination.

The second phase of the agglutination test, that of demonstrating the formation of a complex by its flocculation, is relatively simple compared with the first phase. Experiments conducted with a view to its elucidation in the case of organisms of the colon-typhoid group show the mechanism of flocculation of sensitized bacteria in this group to be similar to that concerned in the aggregation of suspensions to certain denaturated proteins.

It must be remembered in this connexion that different proteins react differently in the presence of various reagents, as is shown by Chick and Martin (*Journ. Physiol.*, 1912-1913, vol. xlv, pp. 261 and 295). These authors demonstrate that the aggregation of particles of denaturated egg-white is conditioned by the presence of electrolytes and by the range of hydrogen-ion concentration over which the reaction is extended.

The same is true of the aggregation of particles of denaturated serum protein, but the figures applicable to egg-white are not applicable to serum protein, etc.

In the case of serum protein, the flocculation of the particles occurs when electrolytes are present in low concentration, and if these be raised to certain concentrations which bring about aggregation of egg-white, no aggregation of serum protein occurs.

In the same way it is highly probable that certain antibody-antigen complexes are much more susceptible to the flocculating, or to the dispersing, power of electrolytes than are other similar complexes—that is, "similar" only in that they consist of other organisms which have adsorbed their homologous antibodies.

Considering, then, the second phase of the reaction, one may ask the questions: "Why is it that a suspension of organisms remains more or less stable until the organisms are sensitized?" "When the organisms are sensi-

tized, what is the mechanism which determines their clumping together in masses sufficiently large to render them susceptible to gravity?" .

As Liefman has shown (*Cent. Bakt. Par.*, ref. 75, 14, 1913) unsensitized organisms are flocculated only by the process of salting out by means of highly concentrated solutions of magnesium sulphate and ammonium sulphate and therein resemble natural proteins.

Their resemblance to fresh proteins is all the more marked in that some species of organisms are precipitated by certain concentrations of these reagents, while others require stronger solutions to bring this about.

Sensitized organisms — serum-organism complex — on the contrary, behave like denaturated proteins and, like rigid colloids, are susceptible to flocculation by low concentrations of salts.

The unsensitized organisms in a suspension are repelled by, and themselves repel, those adjacent to them by virtue of their carrying a surface electric charge according to the Lippman-Helmholtz hypothesis. The conditions which bring about the neutralization of this charge will determine the flocculation of the suspension.

The charge carried by protein particles in suspension depends in kind and in degree upon :—

(1) The reaction of the menstruum in which they are suspended.

(2) The electrolytes present.

In inquiring into the second phase of agglutination, therefore, the relation which these two factors bear to one another must be considered and the relation which each, or both, bear to the degree of sensitization to which the organisms have been subjected. Furthermore, the influence which other physical conditions may have upon the process must not be lost sight of.

(*a*) *Influence of the reaction of the suspending fluid, in which the interacting bodies are dispersed, upon the process of flocculation, and influence of the valency of the electrolytes upon the process in presence of acid and alkali.*

Considering these questions *seriatim*, it is found that the reaction of the suspending fluid exerts a marked influence on the phenomenon under consideration. This would naturally be expected in view of the fact that the surface charge carried by particles of protein—organisms may be regarded as large protein particles—in suspension depends for its sign upon the acidity or alkalinity of the fluid. When the menstruum is acid the particles carry a positive charge, and when alkaline a negative charge.

The following tables illustrate experiments designed with a view to showing the influence of acid and alkali upon the process of agglutination of sensitized bacteria.

Method.—A twenty-four hours' agar culture of *B. paratyphosus* B is washed off in saline and exposed at 22° C., or 37° C. for twenty-four hours, to the action of 1/1000 antiparatyphosus B bacillus serum of titre 1/8000.

The supernatant fluid is pipetted off and the deposit washed by centri-

fuging at least twice in distilled water. The deposit is then suspended in distilled water, filtered to remove any gross particles that may remain and exposed to the action of NaOH in varying concentration in presence of a number of electrolytes, each of which was, when all the reagents were mixed, equimolecular with 0·9 per cent NaCl. The following table shows the readings of this experiment after two hours at 37° C :—

TABLE V.
Complex-constant.
Electrolyte-constant.
Hydroxide ion-variant.
Two hours at 37°.

	No NaOH control	1 c.c.	0·9 c.c.	0·8 c.c.	0·7 c.c.	0·6 c.c.	0·5 c.c.	0·4 c.c.	0·3 c.c.	0·2 c.c.	0·1 c.c.
NaCl	+	−	−	−	−	−	−	−	−	−	+
K_2SO_4	+	−	−	−	−	−	−	−	−	−	+
KI	+	−	−	−	−	−	−	−	−	−	−
$NaHCO_3$ ..	+	+	+	+	+	+	+	+	+	−	+
Na_2HPO_4 ..	+	+	+	+	+	+	+	+	+	+	+

This experiment shows that the hydroxide ion interferes with the process of flocculation, and that a relatively small concentration of that ion has a marked inhibitory effect. The results with $NaHCO_3$ and Na_2HPO_4 show that if replaceable hydrogen be present in the electrolyte this inhibitory effect is negatived.

The converse of this experiment is shown in the following table. The organisms were sensitized with 1/100 serum, then washed twice as before and exposed to the action of varying proportions of N 50 HCl in presence of the electrolytes named.

TABLE VI.—*B. paratyphosus* B and Homologous Serum.
Complex-constant.
Electrolyte-constant.
Hydrogen ion-variant.
Two hours at 37°.

	N/50 HCl									
Electrolyte N/20	1 c.c.	0·9 c.c.	0·8 c.c.	0·7 c.c.	0·6 c.c.	0·5 c.c.	0·4 c.c.	0·3 c.c.	0·2 c.c.	0·1 c.c.
NaCl.	−	−	−	−	−	−	−	−	−	−
Na_2SO_4	−	−	−	−	−	−	−	−	+	+
"Na_3cit." (neutral) ..	+	+	+	+	+	+	+	+	+	+
$BaCl_2$	−	−	−	−	−	−	−	−	−	−

* *Note.*—The citrate result is "falsified" in respect of the influence of valency owing to the replaceable Na of the salt.

It may be noted that the above results indicate that the inhibitory effect of hydrion is more marked in the presence of monovalent anions than in the presence of divalent anions. The reason for this will be considered later.

I have purposely omitted from this section of the work a detailed consideration of the influence of polyvalent kations or anions upon the process of flocculation, as these are somewhat difficult to investigate. The polyvalent kations have much the same influence upon unsensitized organisms as they have upon sensitized organisms, owing probably to the formation of metal hydroxides in the system in the form of precipitable gels. The polyvalent anions also present difficulties owing to their dissociation ; thus, using citrates, if a neutral solution of the salt be employed the following difficulty arises : the effect of acid cannot be readily estimated owing to the presence of available hydroxide which will neutralize the acid, while the effect of alkali is also masked, owing to the presence of replaceable hydrogen groups.

The mechanism whereby electrolytes bring about the precipitation of sensitized organisms is explicable on the basis that they neutralize the surface charge carried by the particles. It follows, therefore, that the precipitating ion in the case of acid suspensions of protein is the anion ; while in that of alkaline suspensions it is the kation. It is interesting to note that Burton (Univ. Toronto, Stud. Phys. Lab., 36) found that the addition of aluminium ion to hydrosols of gold or silver in certain concentrations leads to the precipitation of the metal from its sol ; lower concentrations of the Al. ion did not have this effect, and the particles of the sol in the case of the metals under consideration (which bear a negative charge) continued to move in the same direction in an electric field as before, *but at a diminished rate*. If concentrations of Al. ion, greater than that required to bring about the precipitation of the sol, were employed, the particles remained dispersed, but their direction of movement in the electric field was reversed, showing that they had now become positively charged.

In the case of the copper sols, which carry a positive charge, exactly the opposite was noted : polyvalent anions in this case lead to precipitation and ultimately, if added in sufficient concentration, to dispersion, accompanied by a reversal of surface charge as evidenced by reversal of direction of movement in the electric field.

The relative precipitating value of uni-, di- and tri-valent kation in respect of negatively charged colloids and of uni-, di and tri-valent anions in respect of those bearing a positive charge may be expressed according to Linder and Picton (*Journ. Chem. Soc.*, 1895, 66 and 67) by the formula : $1 : \times : \times^2$.

We have evidence that, in the case of sensitized bacilli of the colon-typhoid group at least, the precipitating value of salts obeys in general the same rules in respect of valency, although the actual figures applicable to the precipitation of colloidal As_2S_3 (the reagent used by Linder and Picton) by electrolytes are not applicable to the flocculation of serum-organism complexes. These facts show that in acid suspension or in alkaline suspension, sensitized bacteria behave as do denaturated protein particles, and

the results obtained agree in principle with the findings of Hardy (*Journ. Phys.*, xxiv, p. 170, and *Proceed. Roy. Soc.*, 1900, lxvi, p. 101), and of Chick and Martin (*Journ. Phys.*, xlv, p. 261).

I here recall the fact that these authors show that the precipitation of denaturated egg-white is determined by somewhat different physical conditions from those that bring about precipitation of denaturated serum protein. It follows, therefore, that the optimum conditions for the flocculation of each type of "antigen-antibody complex" would have to be defined before the most specific agglutination results could be obtained. Here again the essentially empirical character of the agglutination test, as ordinarily performed, is manifest.

The following tables illustrate the influence which divalent kations, as contrasted with univalent kations, have upon the process of flocculation of sensitized organisms bearing a negative charge. A suspension of *B. paratyphosus* B was sensitized for twenty-four hours at 37° C. in presence of 1/1000 antiparatyphosus B serum, titre 1/8000. The sensitized organisms were washed by centrifuging in two changes of distilled water. Thereafter the deposit, consisting of sensitized bacilli, was triturated, filtered, and exposed to the action of the following reagents in such concentrations that when the bacillary suspension was added the salts were present in the strengths shown in the following tables:—

TABLE VIIA.

Electrolytes	Dilutions of Electrolytes					
	0·5/N	0·1/N	0·01/N	0·001/N	0·0001/N	0·00001/N
NaCl	+	+	+	—	—	—
Na_2SO_4	+	+	+	—	—	—
"Na_3Cit" (neutral)	+	+	+	—	—	—
$BaCl_2$..	+	+	+	+	—	—

TABLE VIIB.

Electrolytes	Dilutions of Electrolytes															
	N/500·0	N/1000·0	N/1500·0	N/2000·0	N/3000·0	N/4000·0	N/5000·0	N/6000·0	N/7000·0	N/8000·0	N/9000·0	N/10000·0	N/12000·0	N/15000·0	N/20000·0	N/30000·0
NaCl	+	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—
KCl	+	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—
$CaCl_2$	+	+	+	+	+	+	+	+	+	+	+	+	—	—	—	—
$SrCl_2$	+	+	+	+	+	+	+	+	+	+	+	—	—	—	—	—
$BaCl_2$	+	+	+	+	+	+	+	+	+	+	+	—	—	—	—	—
$MgCl_2$	+	+	+	+	+	+	+	+	+	+	+	—	—	—	—	—

The divalent kations are much more potent than are the univalent kations. It is to be noted that the converse of this experiment is also true, viz., that in "acid" suspensions the divalent anions produce flocculation more readily than do the univalent anions.

(b) The Relation which exists between the Degree of Sensitization and the Precipitating value of the Electrolytes present in the Menstruum.

This point is of considerable importance, especially if a proper appreciation of the absorption of agglutinin test is to be obtained. The following example indicates that this relationship is not a simple one, and serves to call attention to its important bearing upon the question under consideration.

If emulsions of *B. aertrycke* and *B. paratyphosus* B be exposed to a serum specific to either, it not infrequently happens that both organisms are equally well agglutinated. One may describe such a finding thus: that both *B. aertrycke* and *B. paratyphosus* B form with, e.g., anti-paratyphosus B serum, complexes which are flocculable by 0·9 per cent NaCl.

It does not necessarily follow, however, that these two complexes are identical, and if one can show that the complexes differ from one another the validity of the absorption test, in its application to the identification of micro-organisms, is much enhanced. In effect the proposition is: Does *B. paratyphosus* B form exactly similar (that is similar from the standpoint of flocculation) complexes with its homologous serum as does *B. aertrycke* with the same, and therefore heterologous serum?

TABLE VIII.

Two hours at 37°.

NaCl					
N/20	N/40	N/100	N/200	N/400	Serum
+	+	+	+	+	1/100
+	+	+	+	+	1/500
+	+	+	+	?	1/1000
+	+	+	?	–	1/2000
+	+	?	–	–	1/4000
–	–	–	–	–	1/8000

$BaCl_2$					
N/400	N/500	N/666	N/1000	N/2000	Serum
+	+	+	+	+	1/100
+	+	+	+	?	1/500
+	+	+	–	–	1/1000
+	+	–	–	–	1/2000
+	–	–	–	–	1/4000
–	–	–	–	–	1/8000

A priori one might hazard a guess that this query is to be answered in the negative; for, were it answered otherwise, the absorption of agglutinin

test would be inexplicable. By varying both the dilution of a serum and the concentration of electrolytes in which an agglutination is carried out, it can be shown that a whole series of complexes, varying in their susceptibility to flocculation, may be formed when an organism is exposed to the action of its homologous serum. The table on p. 130 illustrates an experiment of this kind, in which both serum and electrolyte are variants, while the organismal suspension is a constant.

This experiment shows that an organism can form, along with its own antibody, a variety of complexes differing *inter se* in their susceptibility to flocculation. These complexes cannot be regarded as different in kind, but only in degree. Is it not highly probable then that the complex formed by union of an organism with an heterologous antibody would differ markedly from that obtained by interaction with the homologous antibody?

Light could be thrown on this problem by setting up an experiment in which the suspension of organisms and the serum remain constant, the only variant being the concentration of electrolytes. The following experiment illustrates this :—

Method.—Equal volumes of standard suspensions of *B. aertrycke* and *B. paratyphosus* B were each sensitized in presence of anti-aertrycke and anti-paratyphosus B sera. The agglutinated bacilli were washed twice in distilled water, shaken and filtered through paper to produce a homogeneous suspension which was then "dispersed" in distilled water. Thereafter each of the emulsions so obtained was exposed to the influence of varying concentrations of NaCl and of $BaCl_2$. The following results were obtained.

The results obtained using $BaCl_2$ are not shown in the following table. They fully corroborate those obtained with NaCl.

TABLE IX.

One hour at 37°.

Serum	NaCl	N/20	N/40	N/80	N/100	N/200	N/400
Anti-aertrycke.. ..	*B. aertrycke*	+	+	+	+	−	−
	B. paratyphosus B (titre of serum = 1/2000)	?	−	−	−	−	−
Anti-paratyphosus B..	*B. aertrycke*	+	+	+	−	−	−
	B. paratyphosus B (titre of serum = 1/8000)	+	+	+	+	+	+

Note.—When a simple agglutination was set up in saline with the above organisms in presence of homologous and heterologous sera, it was found that the anti-aertrycke serum agglutinated the aertrycke bacillus and *B. paratyphosus* B equally well and vice versa.

The result indicates, I think, that serum and electrolyte being constant, the physical properties of what might be termed a "co-complex" differ from those of what might be called a "specific complex," the latter being

more susceptible to the flocculating action of electrolytes. This result also bears a striking resemblance to Pauli's investigations noted in Section I, of the influence which salts have upon the heat coagulation of protein, for it appears that the salts in Pauli's experiments play a double rôle :—

(1) By influencing the process of denaturation and

(2) By determining the occurrence of actual flocculation.

The relation which the valency of the precipitating ion of the electrolyte bears to the titre of the serum here calls for attention. If a number of electrolytes equimolecular with NaCl 0·9 per cent be used in place of that salt, it is found that none of them increases the titre of the agglutinating serum, as is shown by the following table illustrating such an experiment :—

TABLE X.—*B. paratyhosus* B.

Two hours at 37°.

Electrolyte equimolecular with 0·9 per cent salt	Dilutions of serum						
	1/100	1/500	1/1000	1/2000	1/4000	1/8000	1/10000
NaCl	+	+	+	+	+	+	−
NaF	+	+	+	+	+	+	−
Na_2SO_4	+	+	−	−	+	+	−
K_2SO_4	+	+	+	+	+	+	−
Na_2CO_3	−	−	−	−	−	−	−
Na_2HPO_4 ..	+	+	+	+	+	+	−
$BaCl_2$	+	+	+	+	+	+	−
"Na_3Cit" (neutral)	+	+	+	+	+	+	−
Aq. Dest. ..	+	−	−	−	−	−	−

Note.—The positive result obtained with 1/100 dilution of the serum in water is probably due to the salts that the serum contains.

On comparing this result with that indicated in Table VII one sees that as one approaches that dilution of serum which might be called its "threshold value" the electrolyte has to be added in greatly increasing concentration, in order to bring about aggregation of the bacteria.

Thus in Table VII it is seen that $BaCl_2$ brings about flocculation in concentration N/400 in presence of 1/4000 serum, while an increase in concentration of the same salt to N 6·5 does not show marked increase in the titre, which is apparently the same as that with NaCl 0·9 per cent.

(*c*) *Effect of other Physical Factors upon the Second Phase of Agglutination.*

It might be expected that the surface tension (intrinsic pressure) and viscosity (internal friction) of the menstruum, would influence the process of flocculation because of the important rôle which these play in determining the disposition of particles in suspension. It has been found, however, that, within fairly wide limits, provided the electrostatic conditions of the particles in suspension do not show alterations concomitant with variation

of these, they in themselves have but little effect in enhancing or inhibiting the aggregation of sensitized bacteria.

One point which is so obvious that it may easily be forgotten, is drawn attention to by Gengou—that if the particles deprived of their surface charge are to come together to form flocculi, they must not be too far dispersed from one another in the suspension, for, under such circumstances, their coalescence will be delayed and the initial lag in this phase of the reaction may be lengthened beyond the time allowed arbitrarily in the laboratory for the demonstration of agglutination. Admittedly this must occur but infrequently. Nevertheless, attention is called to it because it substantiates the plea that to be of value for comparison the agglutination test must be carried out under standard conditions. One of the most easily standardized factors in the process is the bacterial content of the emulsion employed.

The temperature to which the reagents are exposed before or during the test is also of moment, for variation of this condition may well affect both phase 1 and phase 2 of the reaction.

I have already discussed how it may influence the union of antigen and antibody. Its influence on the process of flocculation is even more striking, for it may affect this in two distinct ways :—

(1) By producing a continuous movement of the interacting bodies in the suspension.

(2) By encouraging, or inhibiting, owing to its altering the physical state of certain complexes, their precipitation by electrolytes.

Considering these factors in more detail, the following points appear :—

(1) It is known that gentle shaking of an antibody-antigen complex suspended in saline will hasten in a remarkable manner the process of flocculation. This hastening of the process is probably due to the fact that shaking brings the particles of the suspension closer together and makes one particle roll over the other. As these particles are no longer mutually repellent, they tend to coalesce, and having once coalesced remain together unless violently dispersed by rough handling.

If the reaction be carried out at 55° C. I have observed that the convection currents in the tubes are more active than if the test be made at 37° C. These convection currents have exactly the same effect as gentle shaking of the tubes, and are not too active at this temperature to break up the flocculi. The higher temperature therefore is, *ceteris paribus*, a more satisfactory one at which to perform the test than is body heat ; provided always, of course, that the possibility of introducing an experimental error due to this elevation of temperature is borne in mind, and such error eliminated before incubation at the higher temperature is adopted as a routine procedure.

(2) The mechanism whereby the higher temperature enhances flocculation depends on the fact that certain proteins are more easily flocculated after exposure to an increase in temperature varying according to the

particular protein under examination; they are in fact altered somehow in respect of their physical properties.

Gengou, in the article already quoted, gives a striking example of this. If unheated serum be mixed with a suspension of $BaSO_4$, the serum stabilizes the suspension; but if the serum be previously heated to 65° C. it induces rapid flocculation of suspensions of the same substance. In the former instance, the serum, adhering to the $BaSO_4$, and itself showing no tendency to flocculate, protects the $BaSO_4$, so increasing the stability of the suspension.

In the latter instance, on the contrary, the serum does tend to flocculate of its own accord, and adhering to the particles of $BaSO_4$ it brings about rapid sedimentation of these. The rapidity of sedimentation is especially noticeable in the case of substances like $BaSO_4$ which are heavy, and remain in suspension in water only for a limited time, and only if the particles which form the suspension be sufficiently finely divided.

One would naturally expect then that as proteins are rendered more susceptible to flocculation by elevation of temperature, the formation of certain complexes, while not demonstrable at 37° C., might well be demonstrable at, for example, 55° C. This is particularly likely to be the case, for the process of sensitization, i.e., the formation of a complex, as we have seen, is akin to the process of denaturation.

There is an obvious criticism to the employment of the higher temperature for agglutination. Does the reaction remain specific under the new conditions brought about by the change from 37° C. to, e.g., 55° C.? The answer to such criticism is to be sought by experiment and in experience.

If a sufficient number of organisms be investigated under the new conditions, if a sufficiency of controls be included in the experiments—always especially bearing in mind the employment as a control of a normal serum of the same species of animal as that used for preparing the agglutinating serum—if the results obtained are corroborated by the absorption of agglutinin test, the new conditions may be found to be valid in that they yield specific results.

From this again it can be seen that the test is empirical, for until we know the optimum conditions for the demonstration of agglutination in respect of these factors, the value of the agglutination and the absorption of agglutinin tests for the identification of micro-organisms, can only be established on results obtained.

SECTION III.

Practical Considerations and Discussion.

The points raised in Sections I and II of this communication indicate that the whole process of agglutination depends upon a number of finely balanced physico-chemical reactions. The formation of a flocculable "complex," and its sedimentation, are both governed by physical forces,

and it is apparent that the fine balancing of these forces may in some instances be of paramount import—if consistent results are to be obtained.

In carrying out the agglutination test and the absorption of agglutinin reaction, it is essential that those factors which are susceptible of standardization be standardized; especially in view of the complexity of certain of the reagents employed.

(1) While serum cannot be standardized satisfactorily, as its activity can only be estimated in terms of purely arbitrary units, I think that it is advisable to employ only the serum of animals whose course of immunization has been of short duration.

(2) To use only a serum which is found to react consistently with several representative strains of each serological type of organism which it is proposed to investigate, and

(3) To elaborate a standard routine technique and scrupulously to adhere thereto throughout each series of experiments which are to be compared one with another. The standards adopted for the examination of one group of micro-organisms may differ considerably from those adopted for the study of another group, e.g., typhoid technique differs somewhat from that used for tetanus.

The standardization of technique involves :—

(*a*) The employment of sera of approximately equal titre in all experiments dealing with allied organisms. The titre selected for one species would not necessarily be that selected for another, but in respect of all members of one group the titration of the serum to a definite point should be rigidly adhered to.

(*b*) The use of standardized suspensions of organisms of approximately definite bacterial content and always prepared in exactly the same way, both for the agglutination test and for the absorption of agglutinin test.

The need for the exercise of such care in the preparation of the suspensions is emphasized by the findings of Scheller (*Cent. f. Bakt.*, xxxvi, 1904, and xxxviii, 1905), who shows that higher agglutination titres are obtained with *B. typhosus* previously heated to 65° C. than are obtained by the same organism unheated. Further, these heated bacilli are more avid of antibodies than are the unheated organisms.

(*c*) Saline or other electrolyte employed should be made only with distilled water, and, as it is easily prepared, should be made up freshly each day.

(*d*) The nature of the medium on which the cultures are made, especially the standardization of the reaction, should be noted and care should be taken to avoid injuring the medium. It is also advisable to get rid of condensation water before proceeding to wash off the growth. The reason for these precautions is that if the medium be alkaline there is danger that a too alkaline suspension be obtained, and so inhibit the reaction. If medium, especially agar, be present in the suspension, it is conceivable that it may act as a protective colloid, and so may inhibit both the union of the antigen with antibody and the process of flocculation.

(*e*) I have found that, when performing the absorption of agglutinin tests in the examination of meningococci, it is advisable to use freshly prepared sera, as these give clearer cut results than do sera which have been in store for some months, even under the best conditions. The reason for the discrepancy between freshly made sera and those that have been stored I cannot suggest and am not at present in a position to explain.

(*f*) If carbolized suspensions are used the strength of the phenol should not be greater than 0·5 per cent. It should only be added after the emulsion is heated—if heated emulsions are employed—and only the purest phenol can be added to suspensions if comparable results are to be obtained.

The results quoted in Sections I and II of this communication show why we are compelled to standardize the reagents and the procedure of the reactions under consideration, owing to the errors which are liable to be introduced, were such not done.

If the standards just laid down be adhered to, the results obtained over long periods are found to be comparable with one another and, notwithstanding the apparent complexity of the tests, they are relatively easily carried out and give consistent results after a certain amount of experience has been obtained. Indeed, when the necessary experience has been obtained they are carried out more easily and quickly than are fermentation tests, for these call for extreme care in the isolation of cultures and in the assessment of the results given by growth in the carbohydrate media. When a positive reaction is obtained in the case of a fermentation test, one must be assured that the result is due to the organism under examination and not to a contamination. Any one who has been engaged on the study of certain groups of bacteria, and notably on a study of the anaerobes, cannot but be deeply impressed with the possibility of error due to this cause in case of inexperienced workers. On the other hand, when a negative result is obtained in the case of a carbohydrate test, one must be satisfied that not only did the inocula live in the sugar medium, but that multiplication took place. These points can only be verified by subculture and re-isolation, which occupies valuable time, and the results obtained are worthless unless the investigator be highly skilled.

It has been my experience that, when my agglutination tests have given unsatisfactory and discrepant results, some detail of my technique has been at fault and a repetition of the test with rigid attention to detail always resulted in consistent findings being obtained.

It will be noted that the question of specificity has not so far been discussed in the present communication, for reasons indicated in the introductory paragraph. I wish to point out, however, that the theory of specificity of serum reactions, which, consciously or unconsciously, dominates nearly all the writings on the subject, is the purely philosophical hypothesis of Ehrlich. This savant visualized organisms as consisting of a number of definite " antigens," certain of which are common to each member of a group of organisms and others specific to individual members

(serological types) of the group, in exactly the same way that he visualized each type of antibody as having a peculiar chemical structure. Thus an "agglutinin" was diagrammatized as having a combining chemical group and a flocculating chemical group; and an "amboceptor" as having one group which combined with "antigen" and another with complement. Whenever a new phenomenon was demonstrated in serology, it was only necessary to add another side-chain, or construct a new diagram, and the new reaction was explained.

According to this view, each of the antigens of one organism is assumed to be able to call forth, when that organism is inoculated into an animal, a response specific to itself, and the antibodies for each are assumed to be chemically different one from another.

Such an assumption is not by any means necessarily valid, and indeed, if we assume without question its validity, it follows that the experiment described in Section II, subsection (*b*) (Table VIII) of this article, would indicate that the complex formed by *B. paratyphosus* B with 1 100 dilution of its homologous serum in presence of NaCl, N/400, might differ not merely in degree, but in kind, from the complex resulting from the union of the same quantity of the same emulsion with 1/4000 dilution of the same serum in presence of the same electrolyte, or with N/20 NaCl in presence of the lower dilution of the serum.

I conceive, therefore, of group reactions being due possibly, not to closely allied organisms having a definite group antigen common to all the members of the group, but to each member of a group of allied types or related species consisting wholly of specific antigens, which however form complexes with heterologous sera more or less easily flocculated in presence of certain concentrations of certain salts, depending upon how close or how remote the relationship may be between the serum and the organism forming the complex.

To conjure up a new antigen common to all those members of a group of organisms which happen to react with one serum, and to extend the process indefinitely as has been done in order to explain why sera are not strictly specific, lays the whole subject of agglutination and other serological tests under suspicion. The same objection may justifiably be made to such reasoning concerning the multiplicity of antigen in one organism as Bordet, rightly I think, advanced in his criticism of the whole side-chain theory of immunity. Bordet says: "Everyone agrees naturally that the numerous antibodies which the study of immunity has brought to our knowledge and which are active on such different elements as bacteria, cells, toxins and the like, should not be considered as identical, inasmuch as they may be distinguished as regards specificity, or in other words, since they unite with different antigens. But, in addition to this incontestable difference of specificity, Ehrlich has imagined another one which is more far-reaching and which deals with the molecular structure of the antibody. Indeed he classes these antibodies in accordance with their molecular

structure into three genera: antitoxins with a single combining group, agglutinins and precipitins with a single combining group and an additional functional group which brings about agglutination or precipitation; and finally sensitizers which have two combining groups in their molecules, uniting on the one hand with the cell that is affected and on the other side with the alexin (complement), and hence the name of amboceptor.

"In every instance, according to this classification, the phenomena observed are attributed to special properties in the antibody and never to those in the antigen. As a matter of fact, these phenomena should be related not as regards antigen or antibody considered separately, but as regards the complexes which result from their union, and it is evident that the special properties of the antigen must affect markedly and perhaps to a preponderating degree the qualities of such complexes."

It is apparent from this quotation that Bordet's attention is focused especially upon the antibody. But when the above was written the evidence was not clear that the same criticism could be applied to Ehrlich's conception of antigens. Indeed, Bordet apparently agrees to some extent with Ehrlich's view, or at least he does not specifically refute it, that there may be a number of *definite* and therefore chemically different agglutinogenic antigens in one variety of micro-organism. In view, however, of the more recent findings in the study of the physico-chemical aspect of the subject of serology, it is quite logical to apply the same reasoning to the antigen as Bordet applies to the antibody. Further, in view of the results indicated in Section II, subsection (*b*) of this communication the application of the criticism is even wider than that indicated by Bordet in respect of antibodies, since it can be applied to the discussion of the mechanism of agglutination in the presence of heterologous serum in contrast to that in presence of homologous serum.

Regarded superficially, this concept would appear to invalidate the application of the absorption of agglutinin test to the identification of micro-organisms. For, if a complex be formed, the flocculation of that complex should result in removal of antibody from the fluid, as stress has been laid upon the fact that neither organism nor serum is flocculated in the process of agglutination, but that the floccules consist of both serum and organism in some form of physico-chemical combination.

Far from invalidating the test, however, this argument could be used further to establish its value. It is known that some complexes are especially easily flocculated under certain circumstances, and that in such cases only a very low concentration of antibody requires to be united with the organism in order to determine the formation of a complex flocculable in presence of, e.g., 0·9 per cent NaCl. The results obtained, performed with suspensions made in saline, indicate, therefore, that the degree of adsorption of antibody by heterologous mixtures is much less than by homologous mixtures, and indeed, in most cases, the adsorption which occurs with heterologous mixtures is almost negligible. This really means

that phase I. of the agglutination test is always specific, while phase II. shows specific results only if the physical conditions of the experiment are such as to allow of the specificity of phase I. being demonstrated.

SECTION IV.

Results obtained in applying the Agglutination and the Absorption of Agglutinin Test to the Investigation of Gram-negative Cocci which produce Primary Meningitis in Man.

In view of the fact that the validity of applying the agglutination and absorption of agglutinin tests to the demarcation of the meningococcus group of organisms, and to the differentiation of these *inter se*, may be regarded as debatable, I think it would be of some interest to give a summary of the results obtained in the examination by the methods in question of a consecutive series of this organism obtained from the cerebrospinal canal.

We may divide those results into those which are quite specific and show that the organisms under examination when tested by means of the agglutination method, using the four type sera of Gordon, react with one and with only one of these, and those which are not specific, the organisms reacting with more than one of the type sera.

(*a*) *Results which are absolutely unequivocal in respect of the Four Type Sera.*—Provided that the sera issued by the Central Cerebrospinal Fever Laboratory for the investigation of epidemic meningitis among troops were absolutely specific, and if these sera represent all the organisms which might be designated meningococci, every specimen of coccus isolated from the cerebrospinal fluid in cases of the disease should, when tested with these sera, give a reaction corresponding to one of those symbolized as *a*, *a*1, *a*2, etc., in the following table. No specimen should be met with giving a reaction corresponding to that symbolized as X.

It is, however, too much to expect of this, as of any biological method of investigation, that the experimental error will be completely eliminated. It would indeed be surprising if the Gram-negative diplococci which produce primary meningitis did not show relationship one to another when tested by biological methods.

Of the 356 cocci investigated by the agglutination test in the Central Laboratory, 234 gave absolutely specific results as follows:—

(1) Fifty-four different specimens gave a positive reaction to a dilution of 1/400 with Type I serum only.

(2) Thirteen reacted with Type I serum to a dilution of 1/200.

(3) One reacted with this serum to a dilution of 1/100.

(4) Eighty gave unequivocal results to a dilution of 1/400 with Type II serum and reacted with no other serum.

(5) Thirty-nine behaved similarly to a dilution of 1/200 of the same serum.

(6) One coccus reacted in presence of 1/100 dilution of Type II serum.

(7) Twenty cocci reacted specifically to Type III serum to a dilution of 1/400.

(8) Three reacted similarly, but to a dilution of 1/200.

(9) Sixteen cocci reacted specifically to Type IV serum up to a dilution of 1/400.

(10) Seven gave a specific reaction with this serum to a dilution of 1/200.

That is, 234 of the 348 cocci gave unequivocal type results.

In making this total of the number of cocci which react specifically, I have excluded two strains, No. 3 and No. 6, owing to their poor agglutination.

(11) Eight strains of the organism failed to react in any way with any of the four type sera. Two of these were forwarded to the laboratory not as cultures but as suspensions.

TABLE XI.

Formula of reaction	Type I serum			Type II serum			Type III serum			Type IV serum		
	1/100	1/200	1/400	1/100	1/200	1/400	1/100	1/200	1/400	1/100	1/200	1/400
a	+	+	+	−	−	−	−	−	−	−	−	−
a_1	+	+	−	−	−	−	−	−	−	−	−	−
a_2	+	−	−	−	−	−	−	−	−	−	−	−
b	−	−	−	+	+	+	−	−	−	−	−	−
b_1	−	−	−	+	+	−	−	−	−	−	−	−
b_2	−	−	−	+	−	−	−	−	−	−	−	−
c	−	−	−	−	−	−	+	+	+	−	−	−
c_1	−	−	−	−	−	−	+	+	−	−	−	−
c_2	−	−	−	−	−	−	+	−	−	−	−	−
d	−	−	−	−	−	−	−	−	−	+	+	+
d_1	−	−	−	−	−	−	−	−	−	+	+	−
d_2	−	−	−	−	−	−	−	−	−	+	−	−
X	−	−	−	−	−	−	−	−	−	−	−	−

Note.—Cultures reacting according to formulæ a_2, b_2, c_2, or d_2, have been classed as inagglutinable, as, without verifying such a finding by applying the absorption test, and thereby definitely placing such cocci, it would be inadvisable to regard them as conforming to any of the four recognized types.

Commenting on these results it is remarkable, when it is borne in mind that we are dealing with what are admittedly closely allied organisms, that so high a proportion is susceptible to classification by the test employed.

(*b*) *Results in which the Reactions are not absolutely Specific, but show a Group Relationship.*—(1) Examples of what may be called the I to III group type and the II to IV group type.

Most authorities on the meningococcus agree that there are two main types of organism included in the meningococcus group. By employing the absorption of agglutinin test, it has been shown that Type I of the French authorities includes a small sub-group which, tested by this method, fails to absorb all the antibodies from Type I serum.

This small group is designated Type III at the Central Laboratory and it will be seen from the results in the previous paragraph that a number of strains of this organism are differentiated by agglutination alone from the other types, including Type I, by means of a specific Type III serum.

In view of the relationship, we should expect that a number of organisms which react with Type I serum would also react to a greater or less degree with Type III serum.

In all, sixty-three specimens of the organisms under consideration react with both Type I and Type III serum. The following table indicates the degree of reaction obtained with these cocci.

TABLE XII.

Formula of reaction	Type I serum			Type II serum			Type III serum			Type IV serum		
	1/100	1/200	1/400	1/100	1/200	1/400	1/100	1/200	1/400	1/100	1/200	1/400
A	+	+	+	−	−	−	+	−	−	−	−	−
B	+	+	+	−	−	−	+	+	−	−	−	−
C	+	+	−	−	−	−	+	−	−	−	−	−
D	+	+	−	−	−	−	+	+	+	−	−	−
E	+	−	−	−	−	−	+	+	+	−	−	−
F	+	−	−	−	−	−	+	+	−	−	−	−
G	+	+	+	−	−	−	+	+	+	−	−	−

(1) Thirty-one cocci react in a manner corresponding to the formula designated A in the above diagram.

(2) Nineteen according to formula B.

(3) Three according to formula C.

These may be regarded in all probability as Type I cocci.

(4) Three react according to formula D.

(5) Two to formula E.

(6) One to formula F.

(7) Four to formula G.

These organisms were all proved on subsequent examination—even those reacting to formula G—by the absorption of agglutinin test to be identical with either Typé I or Type III cocci.

As in the case of the I—III groups, a similar affinity is noted between groups II and IV; Type IV is not recognized by the French authors, and like Type III in its relation to group I, is regarded by some as merely a variant of II. Using the absorption of agglutinin test, Type IV can be clearly differentiated from Type II. The following table illustrates the

reaction obtained with specimens of cocci which show agglutination in presence of Type II and Type IV serum.

TABLE XIII.

Formula of reaction	Type I serum			Type II serum			Type III serum			Type IV serum		
	1/100	1/200	1/400	1/100	1/200	1/400	1/100	1/200	1/400	1/100	1/200	1/400
A	−	−	−	+	+	+	−	−	−	+	−	−
B	−	−	−	+	+	+	−	−	−	+	+	−
C	−	−	−	+	+	−	−	−	−	+	−	−
D	−	−	−	+	−	−	−	−	−	+	+	+
E	−	−	−	+	+	−	−	−	−	+	+	−
F	−	−	−	+	+	+	−	−	−	+	+	+

(1) Twelve cocci react according to formula B.
(2) Three according to formula C.
(3) Two react to formula C.
(4) Three react to formula D.
(5) One reacts to formula E.
(6) Seven react to formula F.

In all, then, 28 specimens give II—IV group reactions; 17 of these are presumably Type II cocci, 3 are presumably Type IV, and 8 are equivocal, reacting equally well with Type II and Type IV sera.

The total number of organisms giving I—III and II—IV group reactions is therefore 91.

There remain, therefore, 23 cocci which cannot be placed either as specifically type cocci or as cocci showing the common group relationship of I—III, or II—IV.

The table on p. 143 illustrates the reactions of these cocci with the four type sera.

Of these cocci, therefore—

(1) Nine react in such a manner that they may be regarded as probably Type I cocci.
(2) Five as probably Type II.
(3) Two as probably Type III.
(4) Three as probably Type IV.
(5) Four are equivocal in their reactions.

These cocci have also been submitted to the absorption test and the majority of them qualify definitely as belonging to Types I, II, III, or IV.

Summarizing the agglutination results, then, 346 of the 356 cocci react with one or more of the type sera of Gordon. Ten specimens did not agglutinate. Included in the ten which fail to react are two which were received as suspensions, and two which were ruled out owing to their reacting in presence of 1/100 dilution, and no higher dilution of serum.

Revising the results, one may say that only 8 out of 354 failed to give an agglutination, an experimental error of 2·2 per cent.

In order, further, to control the findings obtained by the agglutination test as applied to the investigation of spinal strains of the organism, it has now been the practice of the Central Laboratory for some time past to verify these by means of the absorption of agglutinin reaction. The details of the technique of this reaction I shall here not discuss as this is fully described in an article on "The Differentiation by Means of the Absorption of Agglutinin Test of the Types of Meningococci obtained from the Cerebrospinal Fluid of Cases during the Current Outbreak of Cerebrospinal Fever" (THE JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, July, 1917).

TABLE XIV.

Culture	Type I serum			Type II serum			Type III serum			Type IV serum.		
	1/100	1/200	1/400	1/100	1/200	1/400	1/100	1/200	1/400	1/100	1/200	1/400
29	+	+	+	+	−	−	−	−	−	−	−	−
42	+	+	+	+	−	−	−	−	−	−	−	−
72	+	+	+	+	−	−	+	−	−	+	−	−
70	+	+	+	+	−	−	+	−	−	+	+	−
174	+	+	+	+	−	−	+	+	−	+	−	−
84	+	+	+	+	−	−	+	−	−	−	−	−
77	+	+	+	+	+	−	+	+	−	−	−	−
396	+	+	+	+	−	−	+	+	−	−	−	−
82	+	+	−	+	−	−	−	−	−	−	−	−
31	+	+	+	+	+	+	−	−	−	−	−	−
170	−	−	−	+	+	+	+	−	−	−	−	−
214	+	−	−	+	+	+	−	−	−	−	−	−
379	+	+	−	+	+	+	−	−	−	−	−	−
315	−	−	−	+	+	+	+	−	−	+	−	−
168	−	−	−	+	+	−	+	−	−	−	−	−
335	−	−	−	−	−	−	+	+	+	+	+	−
181	−	−	−	−	−	−	+	+	−	+	−	−
179	−	−	−	+	+	−	+	+	−	−	−	−
196	−	−	−	+	+	+	+	+	+	+	−	−
Ex. I	+	+	−	−	−	−	−	−	−	+	+	+
Ex. II	+	+	−	−	−	−	−	−	−	+	+	+
75	+	−	−	+	−	−	−	−	−	+	+	−
398	−	−	−	+	+	+	+	−	−	+	+	+

In this series of observations, 107 cocci were completely investigated, being tested each with all of the type sera. Of these 107 cocci, 101 qualified definitely as belonging to one or other of the types defined by Gordon; six could not be so placed, but of these three had died before the investigation was completed.

This inquiry brought to light an interesting point in respect of Type II. Absorption showed that the sera produced by certain cocci agglutinated all the representatives of the group, but were not necessarily absorbed by contact with all of these. Other strains gave sera which were less potent in that they did not agglutinate so many strains to the full dilution of 1/400. They did, however, agglutinate both the organism used for immunizing the animal and a number of other strains provisionally classed as Type II to the full titre, and they were absorbed by the majority of the members of the group.

Type II appears to include a complex sub-group and shows considerable variation among the cocci comprised therein. A Type II serum can be produced which is suitable for the agglutination test, in that all the members of the group are agglutinated by it, but such a serum is absorbed only by a limited number of specimens of Type II cocci.

The investigation, by the absorption test, of cocci provisionally classed as Type II is therefore a difficult procedure, and more than one serum must usually be absorbed before the organism can be definitely placed.

Ten strains provisionally classed as Type II cocci, and available for examination at one time, were used for absorbing three different Type II sera. The results obtained in the experiment are summarized in the following diagram:—

TABLE XV.

Coccus	H. serum	Mi. serum	D. serum
(xxvi) Ou.	—	+	+
(xxxi) Wy.	—	+	+
(v) D.	—	—	+
(xvi) F.	+	—	—
(iv) Ja.	—	+	+
(xxix) New.	+	+	+
(i) A.	+	+	P.
F! Har.	+	+	P.
(xxviii) Eng.	—	+	+
(xxxii) Clen.	—	—	+

+ = Complete or marked saturation.
— = No saturation.
P. = Result equivocal.

One of the cocci absorbed all three sera—it would be suitable for the preparation of an agglutinating serum; seven absorbed two of the sera, and two absorbed only one.

If, in immunizing animals, a coccus is employed which produces a serum similar to that designated "H" in the above diagram, a serum is obtained which is suitable for the examination of Type II cocci by the agglutination test. This serum may, however, be unsuitable for the examination of these by the absorption test in that only a limited number of Type II cocci will remove from it all the agglutinins.

In testing cultures, especially those of nasopharyngeal origin, the least specific (i.e., most difficult to absorb) serum should be used in order that we may be assured that cultures are not being discarded because of an ultra-specificity of the serum employed.

For similar reasons, when we are doing absorption tests with cocci provisionally classed as Type II the reaction should always be performed in duplicate.

(*a*) With the most "specific" and

(*b*) With the least "specific" Type II sera available.

Conclusion.

The results reviewed in this section indicate that the organisms responsible for the current outbreak of cerebrospinal fever amongst the military forces are comprised, with remarkably few exceptions, in the four types of meningococcus defined by Gordon.

It might conceivably be contended, however, that the agglutination test does not serve to distinguish the meningococcus from other Gram-negative cocci that are not infrequently found in the nasopharynx, and which are so like that organism both in morphological characters and cultural reactions as to be indistinguishable from it thereby.

While engaged in studying the spinal strains of the organism by means of the absorption of agglutinin test, I took the opportunity of examining a number of specimens of Gram-negative cocci obtained from the nasopharynx, which had been regarded as meningococci because of their agglutination reactions. In respect of agglutination and absorption of agglutinin these cocci behaved as did the strains of spinal origin.

When examining the nasopharynx of a large number of men, there are not infrequently obtained cultures of organisms closely resembling the meningococcus which fail to react under standard conditions with any of the type sera. Are these meningococci or are they not?

The investigation of a consecutive series of forty such cocci has been completed and it was found that none of them absorbed the agglutinin from any of the four type sera. In examining these, the standard technique was used and each coccus was tested against five sera—Type I, Type III, Type IV and two specimens of Type II—to eliminate possible error due to the complexity of Type II.

Some of the pharyngeal cocci which fail to absorb the type sera may, when inoculated into animals, produce agglutinins which in high concentrations agglutinate certain strains of meningococci. This is especially liable to occur if the process of immunization be prolonged. It might, therefore, be suggested that such organisms could in course of time evolve into meningococci.

Up to the present, however, they have not been in our experience encountered invading the meninges with sufficient frequency during the current epidemic to justify their being regarded as pathogenic. It seems, I think, inadvisable—in the present state of our knowledge at least—to accept a hypothesis based on group agglutination, that the evolution of pathogenic from non-pathogenic organisms, if it occur at all, occurs sufficiently rapidly to invalidate the employment of serological methods in the identification of micro-organisms of known pathogenic significance.

Surely the most ardent evolutionary hypothesist would not insist that the Old World apes must needs be endowed with the intellect and other attributes of man because the serum of those animals gives a positive reaction with anti-human precipitin?

RECOLLECTIONS OF AN ATTACK OF YELLOW FEVER.

By A PATIENT.

WHO is there who will not confess on due reflection to having wasted valuable opportunities and much time pursuing theories not founded on fact, instead of facing every new problem with an open mind?

It used to be customary to regard yellow fever as a disease strictly confined to the sea-coast. Even Sir Patrick Manson, in the 1908 volume of his "Tropical Diseases," after citing the exceptions to this rule, explains them away, saying: "In spreading inland it follows the lines of communication—railways, canals, navigable rivers."

Another common belief is that the *Stegomyia fasciata* is a strictly domestic mosquito. Yet there are specimens in the British Museum that were developed from eggs deposited in calabashes of water placed in wild bush remote from human habitations and inhabited only by baboons and various antelopes and birds, by hyænas and an occasional lion or two.

Carefully reared in these doctrines I landed in a remote bush station of the Northern Territories of the West Coast of Africa, situated far from Coomassie, the nearest railway station, and quite out of any line of communication such as would give facilities for the spread of yellow fever. In spite of my training, natural curiosity and perhaps scepticism made me suspect that yellow fever was a cause of certain deaths from obscure causes. But post-mortems were never allowed by the natives, and on the only occasion when I did insist on one the police stood to arms for my protection till I had finished. I suspected the occurrence of yellow fever in cattle too, but the case of Imoru Grunshi and another native policeman quite eluded my grasp till I went down myself. I well remember Imoru, I should know him again if I met him. He had low fever and no malaria parasites in his blood. He had headache too, and was very weak, but would not come into hospital, and kept on attending hospital daily, looking deadly ill. On the fifth day I missed him and being anxious, sent the dispenser down to see him. He said he was very bad and his urine was like pure blood, so I sent for a specimen. It arrived next day and was merely high-coloured urine, and Imoru brought it himself. My interpreter was not brilliant at any language, and that was all I could find out by his help. However, I saw Imoru's eyes were deep yellow and thought of yellow fever, but the patient was fairly well now, temperature normal and pulse a little quick, but he felt much better and finally the fetish of the hinterland's immunity dispelled the thought for a while.

Another such case arose, but it was not so striking as Imoru's. He got well too.

I made inquiries and found that the Germans recognized yellow fever

occurring up as far as San Salemango in Togoland, but I did not find out how they accounted for it.

I was the next to go down and was at last thoroughly convinced that the disease was endemic where I was stationed.

At the height of my own illness I recollected the case of Imoru Grunshi and mentioned it to the doctors who attended me and on recovery mentioned it to my successor, hoping to give him a clue to the proof that yellow fever was endemic in the district.

On September 6, 1913, the District Commissioner was relieved at Bole, Northern Territories, Gold Coast, by his successor. A large gathering of chiefs came to welcome back the relieving District Commissioner whom they adored. At night I went to dinner to meet the new arrival, and during the course of the dinner my interest suddenly flagged. Everything had lost its taste, and I felt queer. Asking the host's permission, I took my temperature and found it to be 101. I retired at once to bed, as a matter of precaution, as there was scarcely any reason but the temperature to excuse it.

I slept very well and next day was in exactly the same condition, and kept bed all day, feeling very drowsy, but quite satisfied with my condition. The District Commissioner going on leave called to say good-bye and settle some affairs, and I got up out of bed most unwillingly to get something for him. On returning I felt a stinging at the side of my left knee, and caught a tsetse-fly fastened on the spot. I recognized it easily as *Glossina tachinoides*, and remember being extremely annoyed at it. This was Sunday morning, and I spent the day and the next two in bed, thinking I had a low malaria. The temperature scarcely varied, and I had no discomfort, and by Wednesday morning I felt justified in getting up early, and going over to attend to patients. I had moreover many cultures of trypanosomes going on, and an interesting aecidiomycete, whose life history I was working out. There was also cattle disease, which I looked on as akin to yellow fever, and I did not want to miss any chance to dissect a dead animal.

These three days of fever were uneventful, and I was immensely surprised on finishing hospital duties that I had scarcely power to get back to my house. On getting back, however, I took out the microscope and was horrified to find I could not attend or take any interest in what I was doing. Luckily the new District Commissioner came over and distracted my attention, and I put away the microscope. On Thursday and Friday and the most of Saturday I made slight progress. No rise of temperature ever took place, but I noticed that I could get a rise to 103° F. easily by putting the thermometer in my mouth immediately after a meal. This rise was very transitory, and I regarded it as evidence that all was not well, as the greatest rise I ever could get in health in this way was 101° F., and even then I was not sure that there was not some malaria about me, as I was taking quinine very steadily.

On Saturday I managed my duties so well that I consented to go out for a long walk with the District Commissioner to the south of Bole. We reached old ruins which we discussed. Bole had been overrun by Samory not so very long ago, and it is still full of dead men's bones. We were speaking of these things and our own adventures when the sun began to set, and we saw it would take us all our time to get home by 6 p.m. We set out and got on a little way when I said to the District Commissioner, "I am in for rheumatic fever, and it is a mystery how that should be as I have not got a chill or wetting at all." I discussed the symptoms and said it can't be malaria at all. When we got within sight of my house I gathered my remaining strength and rushed for it, and on arriving shouted for the boy, who helped me to undress, and then I collapsed on the bed and was tucked in carefully by the boy. The District Commissioner came over in half an hour and took the temperature and prescribed quinine. The temperature was 102° F. The headache was simply appalling, and the pains in the stomach were indescribable. Bilious vomiting commenced, and I decided to have some more quinine and mist. alba. My skin was horribly dry, and I had grave suspicions that I had not malaria at all, but something incurable, so I took the quinine merely to keep the District Commissioner from worrying, and to prove that it was not malaria. I vomited incessantly, and between the attacks would tell my kind attendant the funniest stories I had ever heard, hoping to deceive him that I was not so bad as I felt, and to allay his fears. My mind was exquisitely alert, and no sleep came till about 3 a.m., when I was drowsy.

The 14th inst. was dull and uninteresting. The District Commissioner had his duties to attend to, and I could look after myself. At 6 p.m. I had reached 102° F., and at 8 p.m. 106° F. The District Commissioner then took a grave view of the case, and I was startled at 9 p.m. by the arrival of a dozen police with the District Commissioner's own bed. They lifted me out gently from my camp bed and put me in my deck chair, and the District Commissioner had the bedclothes transferred to the new bed. Meanwhile I announced that I had not malaria at all, but in all probability yellow fever. I got him to bring me a sealed tube with a solution of quinine in it, and my hypodermic case, and I injected a dose into my flank. The District Commissioner got very pale, turned away and I thought he would faint, so I said something to show that it was a trifling proceeding indeed, then explained the rationale of the proceeding to him. I said: "This will be my last dose of quinine, if it does not make a very appreciable improvement in my condition in a very short time." I explained that the vomiting might have prevented an effective dose reaching the blood, but the injection would obviate this difficulty, and if unsuccessful, would prove that the disease was not malaria at all. He agreed, and said he would treat me exactly as I desired. That night was spent in the most exquisite agony, and I remember remarking that it was the only time in my life I had been in a bad fix, and failed absolutely to see any humour in the situation. The

vomiting was so sudden and so urgent that I was thrown violently across the bed in my hurry to turn round and keep the bed clean. I remember also rating the District Commissioner very soundly indeed for his folly in sitting up, nursing me at his imminent peril, when my boys were eager and willing to do it and would run less risk. Later on, in the early morning, I opened my eyes and saw him dozing, and his whole face seemed to be black with mosquitoes. Nevertheless he refused to leave me, when the mere misery of the bites alone would have been sufficient justification for beating a retreat to bed.

The next morning when he came to see further what was to be done with me, I told him finally that I really had yellow fever, and would just have to put up with it. The very first thing I wished him to do was to send a telegram to the Governor of the Gold Coast, reporting that I had probably yellow fever, and to wait a full day and then wire again to say I certainly had it. "That," I said, "will ensure that my people at home get fair and speedy warning of the matter, and probably by to-morrow in any case I shall be past all interest in what happens, and won't be able to give you any more instructions." I next asked him to wire to Wa and to Kintampo for help, as he could not go on alone. I then asked him to bring my notes from Sir Patrick Manson's lectures, taken at the London School of Tropical Medicine, and with my own finger pointed out the words—"Treatment: Common sense and nursing. Hot fluid must be supplied as required but on no account must food be given. The patient won't die of starvation in five days." "Now," I said to the District Commissioner, "no food for me for five days, and, further, no medicine either. You can get a pill box of soda bicarbonate from Mr. Monsah, the dispenser, but don't let him send Sternberg's mixture, I would rather die a natural death than have perchloride poisoning added to my tortures. The boys can keep the sparklets going all the time, as I have bulbs to last a year, and they know how to manage the filter." I then pointed out the following words in my own handwriting, copied from Sir P. Manson's own dictation: "Mortality varies. Thirty per cent is the average. Fifty per cent to ninety per cent is an epidemic, or as low as ten per cent. A drunkard never recovers. A temperate liver usually recovers. If thermometer does not rise over 103° F. recovery is invariable. Above 106° F. all die." "Now," I said, "don't worry; you see I don't drink at all, and I have not reached 106° F. yet." I did not know he had told me a lie the night before, and wondered at his silence, and did not know I was to reach 106° F. in less than twenty-four hours.

This was a very busy day for me, vomiting being apparently incessant, but I had time to notice that everything I saw in broad daylight was brilliant yellow, and was very glad I had diagnosed the case even before getting so broad a hint as that. I was highly alert also, and called my steward boy and rebuked him for allowing a hole to wear in the mud floor, and had it filled up at once. That day was really too awful to bear any

description at all, but I still tried to pretend I was fairly well, for the other white man's sake, who was doing his best to help me. About 8 p.m. I was so hopelessly spent that I called him and gave him instructions how to make normal saline, and asked him to prepare three pints, as I intended to have a rectal infusion, slowly, to try to make up for the loss of water from my blood caused by the constant vomiting. I see the good fellow has noted that it took effect in a few minutes. Well, so it did, but I was never nearer death than then. I had administered it much too fast, and when I got back into bed I seriously wondered if I would ever be able to turn on my back again, or would just die on my face. However, I pulled through so fast that I slipped out of bed again the same night and arranged all my correspondence, so that there would be no trouble left for other people who had to look for things.

That night was really the worst I passed. I had been making a new medium from fresh blood serum, and had a good many cultures of trypanosomes going on. The Petri dishes I used were claret glasses covered with champagne glasses. They made delightful media dishes, and I used them for little else. The tornadoes were in full swing just then, and every night one tore through the house from end to end, carrying away papers and books and smashing things I prized highly. And yet people often forget that when they have made only a casual visit of inspection to the coast in the dry season. Rain poured nightly through the roof into my eyes, and added to my indignation. I called the boys, and indeed, as a rule, did not need to call them, they were there on the very first distant moaning of the wind, and covered up my bed with a ground sheet, and so mostly saved me from the dripping through the roof, which worried me much more than the fever. The fever had to be put up with, while the dripping was a thing that could be dealt with. Well, these champagne glasses went the way of all the world at that time, and the crash was terrible.

Then I dreamt strange things, but, realizing their folly, resolved to keep quiet. Then a calm came, a fairly long pause, and I was happy and comfortable. I opened my eyes. It was dawn. My attendant was sitting over me with a bath sponge dripping with cold water. When he saw I was awake he said: "It's all right," and disappeared like a shot. I did not dare to move or sit up. I knew acutely what had happened. I had in fact not dared to sit up for some time before, fearing instant death. But I looked around and felt my arms and legs tugging violently. I was horrified; I was in convulsions. I shouted, "Come quickly. Look at my legs. I'm about done. I can't stop these twitchings, and if they don't pass off in half an hour I will just have to die. Get my keys from below my pillow, and show them to me." He did so, and I showed him the key of the box I wanted opened. He opened it and got a box of hypodermic tabloids. I said, "I am quite clear now. I know I was delirious last night, but I am not now. This is my last chance probably, but if I pull

through the next half hour I will get better, but it will take some time, and you must not give me any food until I ask it. You will find a tube of morphine hydrochloride tabloids in that box. Each is ¼ grain. If you break one into two and give me one half that will be ⅛ grain. You see I understand perfectly what I am talking about. If the morphine acts, good and well; if not, you can't be blamed." He did as I asked him. In fifteen minutes I felt easier, and in half an hour felt sure of recovery. Nothing seemed so plain to me all my life as the action of this morphine, and everything that had happened to me in the last few hours.

In spite of my strict injunctions I see it in the official report that I was persuaded to take Benger's food twice that very day, but it soon was rejected, and did more harm than good. Another futile attempt to palm off tea upon me was made late that night, with the same result, but still I felt sure of recovery, and I do not blame my anxious attendant for his endeavour to get me to retain something.

The next two days were dull and uninteresting. Vomiting was so frequent that the resolution not to take food was not defeated. A medical officer arrived on the second of these days, September 18. He had gallantly ridden seventy miles at a stretch through swamps and tornadoes. His transport had been effected by hammock, and by my own and the District Commissioner's horses. All these unhappy animals have sleeping sickness, and ours were no exception, only mine was not so bad as the other at that time. Well, the other got washed from under the Medical Officer's feet into a torrent, and got stuffed under a bridge. The Medical Officer just managed by superhuman efforts to push it out "with a stick," as he said, and save its life, while he himself stood waist deep on the bridge, to his own great risk. He got in anyhow, and was amazed to find my rapid improvement and ability to take interest in his adventures. I had once made an all night record ride, going fifty miles on one horse through the most romantic country I ever set eyes upon, in the most brilliant moonlight that ever seemed to have shone, and no wonder I was interested. He had beaten that record.

Next day I was sentenced to champagne and Valentine's beef juice. I did not like either. My urine was exactly like the beef juice, and I shivered to see it, and wondered if I would die in that doleful place, or go home with chronic nephritis.

The morning of the 20th opened bright and cheerily. I was as happy as could be. It was Sunday, a totally different day to all others, even although I did the same work as a rule. I wondered if the news had been cabled home. It was worse than all that had gone before, and I thought if I only had had patience nobody need ever have known what I had been through. I wrote home that day but was defeated in a line or two. Only I clearly remember saying, notwithstanding the horror of the previous day, that I would recover without any complications.

The 21st passed quietly by, and a second doctor arrived next day.

That selfsame day my boy Abu the Grunshi came to me much agitated. He was a young savage I had picked up the year before and taught to speak English. This Abu was an apt scholar and also learned to bake bread, to preserve the race of yeast I had raised, and to starch and iron collars and tablecloths. He preferred this life to the up country life of the Kassassie savages among whom I found him. Abu had been out visiting the soldiers. His father was a soldier, and he was welcome among them. He said, "Massah, no black man be fit to live all them nine days and take no chop. Black man he die one time, he go die in three days. White man he be different, different, chop it no trouble him too much. Black man he die when all him belly be empty, nothing live for inside, he no fit to live when him belly trouble him too much. He die too fast."

Next day Abu came in and said, "Massah, all de mammies that live for sojah lines, they go cry to-day and tear out all de hair from them heads. They go cry too much so God hear, and it vex him too much and he go make you better quick." Asked why they did that he said I had cured the serjeant's "mammy" of bad sickness, she go die too soon, and I had put medicine in her arm, and she had got better next day. I remembered then giving her emetine hydrobromide for dysentery and it had really cured her. She then ordered out the "mammies" to hold this day of supplication, and I had to send them a kind message of thanks.

Next day I had time to examine myself more carefully, and noted that my fingers had been bleeding beneath the nails and were all black in consequence, and my skin was guinea gold.

At that time the chiefs of the district began to make very insistent demands to see me. I had lived nine days without food and was getting well, and they could not bear the suspense any longer. I was much worried in this way, and put them off and off. They behaved with the utmost good taste. Never the sound of a drum was heard from the day I lay down till the day I officially received them in great formality. Meantime I carried on well. The doctors came daily to see me. They played golf in the afternoon, and I waited on for recovery, having an occasional moment of anxiety when my stomach was rebellious. I drank vast quantities of cold soda water, going right in the face of Sir Patrick Manson's warm drink regime. My Osler and Macrae was consulted and it was found good to give calf-foot jelly and iced champagne. We had none of these dainties. I fed on tinned "Ideal" milk and sparklet water and managed to live on it. It is absolutely amazing to think what pitiful stuff will support human life that is determined not to be put out. We had no mystifying diet sheets up at Bole. We had medical comforts so-called, and I have said what I thought of them already. "Ideal" milk was good enough and variety enough for me. It may have worried subsequent investigators at Bole to find no diet sheets, but they don't cure people. There was certainly a long-winded medical history left, for I typed it myself from the notes of the doctors who saw me, in quadruplicate, leaving

a copy at Bole, and that before I was able to hold a pen long enough to write an ordinary letter. Well, that was after I got up, of course.

It was on the first of October that I got up. When the chiefs heard of it, they could no longer control themselves, but came to the District Commissioner and said he must tell them definitely when I could receive them. I fixed it for two days later, on Saturday.

On Saturday then I was up betimes, for an invalid. I felt there was something in the air, and sent my steward down to buy a large quantity of kola nuts. When I got into my deck chair on the verandah, I heard drilling on the parade ground, and shortly the police marched up in full dress, headed by the serjeant, who formed them up in two ranks in front of the verandah and stepped in front and made an address. I replied with gratitude, and sent them a present of kola nuts. They then marched off, and the chiefs of the district arrived, headed by the Chief of Bole supported by his interpreter. He addressed me thus. "God has been very good to you in saving your life. We know you love our town, and you have been good to us and worked hard to save the sick, and now you want to build us a new town. We have seen that you were right, for the rains have broken many old houses, and we need good ones. We hope you will come back to us and make everything right, and we thank God for having saved you now." He then stepped forward, bowed low and shook hands, and they all did so in turn. I made a reply and thanked them for all their kindness, and sent them a present. Then the real business of the day began. Native sports were held on the parade ground. Races, high jumping, tug-of-war, horse races, etc., till noon. The District Commissioner and the doctors were the leading spirits, and the natives went heart and soul into the fun. At night a grand native dance was held, and the tom-toms made a deafening din.

That afternoon, by the way, the serjeant's wife called, carrying a present of yams, and a fowl, and some eggs. She was gaily rigged out in her very finest purple velvet cloth. It must have cost a good deal in that country. It suited her admirably. She thanked me for having saved her life not long before, and felt sure that it had some connexion with my own recovery. I thanked her and sent her a present of kola nuts.

The ten days of my convalescence, from September 20 to the day I got up, were extremely happy. The other white men came at least twice a day to see me, and were very merry. But I had a few night terrors. A brain so excessively active as mine had been, exercised with superintending my own treatment, trying to look after my nurse and save him from going down next, and managing the boys, could not fail to be tired.

The house had to be cleaned as rigorously as if I was well, but I neglected my poor horse. It used to run loose as a dog, and when I was well came every afternoon at tea-time to have a lump of loaf sugar from my hand, and then it went away satisfied. The District Commissioner had been on the outlook, however, and he ordered my horse boy to sleep

near the horse, so that no harm could come to it. They say lions used to prowl about, but I never saw one or heard anything but the dismal howls of hyænas. One day, or rather night, the District Commissioner slipped round to the stable and found the horse boy missing. He sent out police and brought him back, and had him up in court next morning. The boy said he had only been away a moment, but when asked why his clothes were also missing, he said if he left them a moment the horse would eat them up. This produced great consternation in court. The natives were sure the boy was lying, but the Commissioner took a philosophic view of the case, and said if the boy could get any horse at all to eat up clothes he would let him off, otherwise he must suffer "one dozen of the very best with the cat." The boy was nothing daunted, and men went out and brought in horses, and one by one they smelt the boy's clothes, only to look disgusted and go away. Then my little horse came up and directly the clothes were presented to it, it proceeded to rend them in pieces. The boy was acquitted.

Well, about these night terrors. No sooner had I closed my eyes to compose myself for the night's sleep, for the days were unclouded, then visitors arrived. Six other selves, all of them me, sat at my right shoulder on the pillow and worried me with their disputes. They disappeared whenever I ordered them or tried to open my eyes. Then I would sometimes waken up and find my feet bare and wonder what right they had to be in the bed at all. They were quite useless, and it took me a few seconds to see the funniness of the idea. No doubt this was just at the time when the kidneys were most severely taxed, for it was quite a late symptom. Another night all the chiefs of the district sat round my bed and talked incessantly. Then, next night, a crowd of old villainous white men, gold diggers, got round me and plotted my death, which did not worry me in the least degree.

It was about the third of October when I had ventured across to hospital to see everything doing, that a boy came and met us and asked us for "them small bottle you put under man's tongue to see if he be sick." We gave him a thermometer, and had visions of yellow fever. Next day I was much weaker. My heart was distinctly bad, but I distilled water to make Giemsa's stain, as we were anxious about the new case. I crept along the house wall for support, but the job had to be done, and it was done. We saw nothing in the stained blood specimen, but the case was typical yellow fever.

When the second invalid had recovered he and the other doctor who had come from the north, and myself, all set out for home. Passing the police lines the whole detachment was found drawn up with the District Commissioner at its head, and I, as senior, dismounted from my hammock and received an address from the serjeant. I inspected the detachment who were in full dress, and replied, then got on the move again, and the force followed in fours. Coming through the town we saw all the

little rolling hillocks that characterize Bole covered with wild savages, armed with formidable Dane guns. They had them rammed with powder, and when we passed crossed them over our heads and let off volley after volley, then rushed on and fired again. Their yells were terrible, and would have been terrifying if we had not known that they were meant for the greatest sign of friendship.

After a mile's hammocking we reached the top of a long hill, whereon were seen the Chief of Bole, his interpreter, " Sir Galahad," the police, and the District Commissioner. A final farewell was said and an affecting scene was witnessed.

After a few days we reached the great river Volta, and then crossed into the forest of Ashanti. We had happy days travelling in the forest despite our weakness, and we never once did less than a full day's journey. We had revolver or rifle practice in the afternoon, and at night our dinner table was illuminated with a bush-made acetylene lamp, constructed out of a jam tin, a coffee tin, and a flour tin, all telescoped into each other in such a way that the coffee tin floated in the flour one and raised the jam tin with its cargo of calcium carbide out of the water whenever enough acetylene was generated to supply the light. Such crowds of insects gathered about that light.

Arrived at Coomassie, we were solemnly condemned to hospital. We squirmed under it at first, but they were very good to us and gave us far too much food. There was a capital little dog in the place whom we stuffed with our excess food every meal till the grievance was abated.

Convalescence in yellow fever is a most rapid process, and I sometimes regret not having been allowed to finish out the twelve months on the coast. We stayed at Coomassie about a week and then left for Seccondee, where we were again solemnly committed to hospital. At Seccondee we were well treated as usual, and in a few days we were on board the ship, homeward bound.

For sheer agony yellow fever must take first rank. It surpasses rheumatic fever in the exquisiteness of the pains, their variety, and incurability. It is sheer madness to give drugs to relieve them. Any drug able to do it would have to be given in an almost fatal dose. In cerebrospinal fever stupor sets in, and although the patient goes raving on, he ceases to feel as acutely. Not so in yellow fever, he keeps alert till nearly the end. There is a limit to the power to feel pain, and whether it is caused by heated irons, or jagged knives, or disease, it ceases to increase beyond that. The sense organs then become exhausted and actually feel less than is going on, but it takes about six days for that to happen. In yellow fever, aspirin, sodium salicylate, and phenacetin never reach the blood or the seat of pain or the brain. They are not absorbed at all. They are not even vomited out, they are shot out with explosive force, and there is danger of rupturing the blood-vessels of the brain with the violence of the action.

It is cruel to force drugs in through the skin, in the delusion that they may do good. Quinine is useless, and if the blood has been proved free of malaria parasites, how on earth can the subsequent giving of quinine be justified? Pilocarpine is worse than useless, as the blood is already too dense, and if the fetish of a moist skin is needful then water must be supplied by rectum. Indeed it is a wise thing to do. It would flush out the kidneys, and reduce toxæmia, and make up for water lost in vomiting. No water is absorbed by the stomach, but it should be drunk constantly to clean out the blood and acid in the stomach, otherwise there will be dry retching, which will soon kill the patient. It is good to put sodium bicarbonate in the water and to have it aerated to make it more pleasant, and the alkalinity neutralizes the excessive acidity of the stomach secretion.

The headache is intractable by any safe dose of any drug. Cold water cloths help it distinctly.

The abdominal pains are peritoneal, and mustard at least distracts one's attention from them. There is a lot of tympanites, and a turpentine and soap enema would be good, and would pave the way for a saline infusion. After one good evacuation of the bowels there is no need whatever to worry for another for about nine days, in a bad case, for no food has been taken, and there is no difficulty in starting the bowels with absolute regularity as soon as food is resumed.

When hyperpyrexia sets in, cold sponging is excellent. If the pathology of yellow fever were constantly borne in mind, the futility of drugging would be realized, and many more recoveries than at present would take place. Saline, soda, sponging and starvation will increase the recovery rate immensely, and to these I attribute my recovery. For stronger men than I, with a better record of coast sickness, have gone down with yellow fever who might have made a better fight if they had not persecuted their attendant to relieve their agony by some drug or other, and we all know how hard it is to refuse.

It would be a good thing if every white man going to the Coast were taught in the plainest language that yellow fever is endemic, the hour of infection being probably between 6 and 7.30 p.m., when men sit out in the open and get bitten most. They should be taught that it is almost certainly fatal, and that any chance they have is in their own hands. They need expect nothing to relieve their pains or shorten their disease in the way of drugs, but they will make things very much easier if they will lie still and drink only water, and never worry about food for days on end.

The Sequelæ.—There are no regrets left, no bitterness. Recovery was well worth the fight. The hair fell out for a time, the nails got black and cracked and became permanently thin. There were patches of anæsthesia and hyperæsthesia all over, which lasted about two weeks. It may have helped to save me that I attempted to be cheerful, but what certainly did save me was the District Commissioner's help, for which I shall ever be grateful.

SOME STRAINS OF ORGANISMS FOUND IN DYSENTERY SUSPECT CASES IN FRANCE, SHOWING PECULIAR AGGLUTINATING PHENOMENA AND SUGAR REACTIONS.

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The observations here recorded are the result of some months' work at a Base in France.

I am indebted to Captain Lazarus Barlow, Pathologist, No. — General Hospital, for the material for the first seven cases; these occurred while I was acting for Captain Sladden, Pathologist, No. — Stationary Hospital.

Later, while acting Pathologist at No. — Stationary Hospital, observations were continued on this material and extended on 120 dysentery suspect fæces received from Captain Sladden. It is not proposed to discuss here in detail the bacteriology of dysentery as laid down in text books on the subject. The types of organisms there described are well known to those who have worked on this disease, and one or more of the types are found in most parts of the world.

These types are all fairly clear cut, the basis of their classification is dependent on sugar reactions and sub-groups are distinguished by their behaviour towards specific agglutinating sera.

The bacteriological diagnosis depends firstly on certain sugar reactions, and secondly on the specificity of the agglutination phenomenon. It is a bacteriological axiom that no dysentery organism ferments lactose nor forms gas in any carbohydrate, and also that the agglutination phenomenon is a strictly specific one—excepting only some interchange of group agglutination such as may occur between members of the enteric group or members of the dysentery group with the specific sera of the respective group.

In isolating dysentery organisms it is usual to give first importance to the fact that these organisms do not ferment lactose, and a medium containing this carbohydrate, such as MacConkey's, is used for plating the fæces. On this medium the dysentery organisms grow as colourless colonies and can be picked out from the common intestinal growths of the *Bacillus coli* group which grow red.

Colourless colonies may be tested at once for agglutination, or later after further sugar tests. Where large numbers of dysentery suspect cases have to be dealt with, a rapid method of diagnosis has of necessity to be adopted, and likely colonies may under these circumstances be tested at once for agglutination; later, if time permits, the more complete evidence of sugar differentiation may be sought with those colonies that show specific agglutination.

In this report are described all organisms that I have succeeded in isolating from a number of dysentery suspect cases, and which give agglutination with specific dysentery sera. In neither their sugar reactions nor

specific agglutinating properties can the majority of these organisms be classed as text-book types. All show the common and characteristic feature of agglutination with specific dysentery sera, but in nearly every case the diagnostic specificity of this phenomenon is confused and complicated by the fact that they also agglutinate with one or more of the enteric group specific sera. For the sake of clearness and brevity this may be called the phenomenon of "multiple" agglutination.

Eighteen cases are reported in all. They can be differentiated on sugar reactions into seven types; one of these types claims seven of the total cases, and falls into the Flexner-Y group as far as can be ascertained with the available carbohydrates. The remaining six types show sugar reactions quite dissimilar to any known dysentery group.

The organisms were all recovered from dysentery suspect cases, that is, cases which had come down the line suffering from diarrhœa with blood and mucus, or with a recent history of such diarrhœa.

It is to be noted that at the time of examination the stools were in the great majority of cases "normal," that is to say, contained neither blood nor mucus macroscopically and microscopically, nor did the stools contain entamœba.

The fact that the majority—eighty per cent approximately—of these cases were at the time of examination passing normal motions is of interest, because it is a stated fact in most text-books that classical *B. dysenteriæ* is only usually recoverable during the early stages of the disease, and ceases to be found when the stools become normal.

These cases are shown in the various tables of this paper, and with the strains of organisms from them, are numbered 1 to 18.

The cases are divided into two series; the first seven belong to Series I, the remaining cases to Series II.

The first series occurred in routine examination over a period of one week, during which time 143 stools were examined. From these only typical non-lactose fermenting colonies which showed agglutination were worked on; these colonies were picked out as they occurred and put through different tests.

In the second series 120 stools were examined, and efforts were made to isolate agglutinating strains whether occurring as discrete colourless colonies in pure culture or mixed from various parts of the plate. In this series use was made of the observation made by Captain Sladden some time previously, viz., that lactose fermenting strains frequently agglutinated with dysentery specific sera. Agglutinating strains were, therefore, sought for both in lactose and non-lactose fermenting colonies and growths.

Technical Routine.

The same procedure has been adopted throughout. The fæces are emulsified in saline and spread with a small loop on MacConkey plates in a series of strokes. The following day growth is tested for agglutination with

specific sera diluted 1 in 300. Discrete colourless colonies are tested separately when present; where no such colonies are evident, growth from three different parts of the plate are emulsified and tested separately. The dilutions are made on microscopic slides by mixing one loopful of emulsion with one loopful of specific serum diluted 1 in 150. The slides are put aside in a moist chamber at room temperature and microscopically examined for agglutination at the end of three or four hours.

Discrete colonies which show agglutination are subcultured direct through the sugars or replated in doubtful cases. Mixed growth showing agglutination are replated from growth itself, from the emulsion, or from both.

In the first series of cases it was found during routine examination of the plate growths that certain non-lactose fermenting colonies which agglutinated with specific dysentery sera also agglutinated with one or more of the specific enteric group sera in routine dilution (1 in 300).

When this was first observed it was thought that "mixed" growths were being met with, and that the cases were examples of mixed dysentery and enteric group infections. Careful isolation of these organisms, subsequent repeated agglutination tests, and the occurrence of this phenomenon again and again in other cases has proved that this is a distinct phenomenon and is not due to mixed growths.

When these agglutination tests are carried beyond routine 1 in 300 dilutions, it is found that in nearly every case the end point with Flexner-Y serum is much higher than with other sera. If the cultures are tested from day to day it will be found that while agglutination with dysentery sera remains constant, agglutination for other sera soon falls below 1 in 300, but does not entirely disappear. Subculturing in ordinary media does not seem to revive this diminished agglutinability to any appreciable extent in cultures a week or two old. When first isolated, heating at 60° C. does not affect the agglutinability of these strains.

Table I shows the agglutination properties of these strains (*a*) when first isolated, (*b*) on first subculture, and (*c*) in culture five to ten days old.

Fresh dilutions of stock sera were made from time to time to check previous results and obviate the fallacy of deterioration of the stock dilutions.

In Series II, 120 fæces were examined. Of these cases, twenty-seven were returned as positive Flexner-Y on routine agglutination of plate growths, with specific Flexner-Y serum.

Efforts were made to isolate these agglutinable strains in every case by subculture and succeeded in the eleven cases tabulated—40·7 per cent (Nos. 8 to 18).

In the unsuccessful cases no agglutinating colonies or growths could be detected in the subculture plates.

In Table II are given the sugar reactions of all strains.

Table III shows the number of types and the number of strains which can be placed in each on sugar reactions.

Neglecting the acid in dulcite formed by the first three strains it is

TABLE I.

Strain	Agglutinations, 1/300 dilutions specific sera (*a*) When first isolated						Agglutinations, end-points. Dilutions, 1/300 up (*b*) First subculture						Agglutinations, end-points. Dilutions, 1/300 up (*c*) Five to ten days old culture					
	Shiga	Flexner-Y	Typhoid	Para A	Para B	Gaertner	Shiga	Flexner-Y	Typhoid	Para A	Para B	Gaertner	Shiga	Flexner-Y	Typhoid	Para A	Para B	Gaertner
1	—	+++	—	++	—	—	—	1/600	—	1/300	—	—	—	1/600	—	—	—	—
2	+	+++	—	+++	—	—	—	1/1200	—	1/300	—	—	—	1/1200	—	—	—	—
3	—	+++	—	+++	—	Tr	—	1/1200	—	1/300	—	—	—	1/1200	—	—	—	—
4	++	+++	—	++	++	—	1/600	1/1200	—	1/600	—	—	—	1/1200	—	—	Tr	—
5	—	+++	—	—	—	—	—	1/300	—	—	—	—	—	1/300	—	—	—	—
6	+	+++	++	+++	+	+	Tr	1/600	Tr	Tr	Tr	—	—	1/600	—	—	—	—
7	—	+++	+++	+++	—	—	—	1/1200	—	—	—	—	—	1/1800	—	1/300	—	—
8	++	+++	++	++	+	—	1/300	1/1200	—	—	—	—	1/300	1/1200	—	—	—	—
9	—	+++	*	*	*	*	—	1/600	—	—	—	—	—	1/600	—	—	—	—
10	—	+++	+++	++	+	*	—	1/600	1/600	—	—	*	—	1/600	1/300	—	—	—
11	—	+++	*	*	*	*	—	1/1200	1/300	1/300	—	*	—	1/600	—	—	—	—
12	—	+++	*	*	*	*	—	1/1200	1/300	1/300	—	*	—	1/600	—	—	—	—
13	—	+++	*	*	*	*	—	1/1200	1/300	1/300	1/300	*	—	1/600	—	—	—	—
14	—	+++	*	*	*	*	—	1/1200	1/600	1/300	1/300	*	—	1/1200	—	—	—	—
15	+++	+++	*	*	*	*	—	1/300	1/1200	1/1200	1/300	*	—	Tr	1/300	1/300	—	—
16	+	+++	*	*	*	*	Tr	1/600	1/1200	1/600	1/600	*	Tr	1/600	1/600	1/300	—	—
17	+	+++	*	*	*	*	Tr	1/1200	1/600	1/300	1/300	*	—	Tr	—	—	—	—
18	+	+++	*	*	*	*	Tr	1/1200	1/300	1/300	1/300	*	Tr	1/600	—	—	—	—

* Not tested.
Tr Trace.
+++ Complete agglutination.
\+ Incomplete agglutination.
— No agglutination.

seen that these three strains, together with Nos. 10, 11, 12 and 17, for which no dulcite was available, form a group of seven which fall into the Flexner-Y group.

Five of these strains show the phenomenon of multiple agglutination. These are the only strains in the whole series which in any way conform to the recognized types of *B. dysenteriæ.*

TABLE II.

Strain	Motility	Gram Stain	Gelatine	Litmus milk			Lactose	Mannite	Glucose	Saccharose	Dulcite
				1st day	2nd day	3rd day					
1	—	..	—	SLA	ALK	ALK	O	A	A	O	SLA
2	..	—	—	SLA	ALK	ALK	O	A	A	O	SLA
3	..	..	—	SLA	ALK	ALK	O	A	A	O	SLA
4	..	—	..	*	*	*	O	O	A	A	SLA
5	..	..	—	*	*	*	O	O	A	A	SLA
6	..	..	..	SLA	ALK	ALK	O	AG	AG	O	SLA
7	..	..	..	SLA	ALK	ALK	O	O	A	A	SLA
8	..	..	—	A	SLA	ALK	O	O	A	A	*
9	..	—	—	A	SLA	ALK	O	AG	AG	O	*
10	—	..	—	SLA	ALK	ALK	O	A	A	O	*
11	..	—	—	SLA	ALK	ALK	O	A	A	O	*
12	..	—	—	SLA	ALK	ALK	O	A	A	O	*
13	—	—	..	A	A	A	A	A	A	O	*
14	—	—	—	A	AC	AC	A	A	A	A	*
15	—	—	—	A	A	A	AG	AG	AG	O	*
16	—	—	—	A	A	A	AG	AG	AG	O	*
17	..	—	—	A	ALK	ALK	O	A	A	O	*
18	—	—	—	A	A	A	AG	AG	AG	SLA	*

* Not tested.

TABLE III.

Types	Lactose	Mannite	Glucose	Saccharose	Type	Number of strains in each type
1	O	A	A	O	Flexner-Y ..	7
2	O	O	A	A	Aberrant	4
3	O	AG	AG	O	,, ...	2
4	A	A	A	O	Atypical	1
5	A	A	A	A	,, ...	1
6	AG	AG	AG	O	,, ...	2
7	AG	AG	AG	SLA	,, ...	1
Total ..	..	..	..	..	.. .. ..	18

This means that out of 143 cases in the first series—of which thirty-one were returned as positive on the assumed specificity of the agglutination phenomenon—only three of the seven non-lactose fermenting strains isolated are typical *B. dysenteriæ.*

Also, in the second series where twenty-seven cases out of 120 were returned as positive on agglutination, only six strains out of the eleven isolated are non-lactose fermenting and of these only four are typical *B. dysenteriæ.*

It is to be noted that the phenomenon of multiple agglutination is common to the strains which conform in their sugar reactions to typical types and also to the strains which do not so conform.

It has been attempted to try and arrive at some proof as to the specificity of these organisms. The chief difficulties have been lack of time due to pressure of routine work and also the fact that complete serological tests could not be done because patients were evacuated immediately following diagnosis. Also these observations are so contrary to the usual conceptions of the bacteriology of dysentery that no systematic scheme of research had been devised to meet such a situation at the time when these cases were occurring.

Parallel agglutination tests were made with sera from the patients from whom the strains in Series I were isolated.

The end-points of agglutination are shown in Table IV.

TABLE IV.—Microscopic Reading after Three Hours Room Temperature.

Serum	Strains							Type
	1	2	3	4	5	6	7	
1	1/40	1/60	1/160	1/160	1/80	1/160	>1/160	Flexner-Y
2	1/40	1/40	1/40	1/160	1/80	>1/160	1/80	,,
3	1/40	1/80	1/80	1/160	1/60	>1/160	1,160	,,
4	1/80	1/80	1/160	>1/160	1/160	>1/160	>1/160	Aberrant
5	1/40	1/40	1/60	1/180	1/40	>1/160	1/160	,,
6	—	Serum of this case not taken					—	,,
7	1/80	1/80	1/60	1/160	1/80	>1/160	>1/160	,,

No data are available as to the date of illness; such information would be of interest as affecting the titre and for comparative scrutiny of the table.

These figures at first sight seem to be of importance and to go a considerable way to support the assumption that these strains are specific, and not only specific but of a correlated type. But all the strains show enteric group agglutinability and the following table shows the agglutinins in the sera. The agglutinations may therefore be due to several factors.

The same sera with which tests in Table IV were made were put up according to Dreyer's method, using his "standard" emulsions.

The readings are given in Table V (A).

I do not consider this single reading of much importance, but the table is included as emphasizing the complexity of the whole position.

The figures are very conflicting, but it is to be remembered that one is dealing with many factors.

The agglutinins in the serum of an inoculated individual suffering from dysentery, and possibly enteric group infection, and from whom an organism has been isolated showing multiple agglutinability, may conceivably give rise to confusion in serological tests.

TABLE V (A).

No.	Date of inoculation	T	A	B	Shiga	Flexner	Y
1	TV/2, January 31, 1916; TAB, August 10, 1916	2,500	1,250	500	Not tested	50	250
2	TAB, May, 1916	1,250	1,250	250	,, ,,	50	250
3	TAB, (?), 1916	2,500	1,250	250	,, ,,	50	250
4	TAB, April, 1916	1,250	> 125	> 250	250	250	> 250
5	TV/2, December 21, 1915	1,250	125	80	40	40	> 250
6	Not known			Not* tested.			
7	TV/, August, 1915.. ..	1,250	—	—	—	25	—

Table V (B) shows the agglutinations given by sera from some cases in Series II by Dreyer's method.

TABLE V (B).

No.	T	A	B	Shiga	Flexner	Y
9	*	*	*	—	—	—
10	*	*	*	—	1/250	—
12	*	*	*	1/25	1/40	1/125
15	1/1,250	< 1/25	< 1/25	—	—	—
16	1/40	1/50	1/250	—	—	—

* Not tested.

Fixation of the Complement Tests.

It was found impossible to carry out complete serological tests with the patient's sera because patients were evacuated early.

The various strains were preserved and were used in complement fixation tests with various sera as detailed later. In these tests the original method was followed, i.e., the complement in the sera to be tested was destroyed and guinea-pig's serum containing a known amount of complement used.

In carrying out these tests it is necessary to heat the bacillary emulsion to 60° C. to destroy any possible hæmolysins; also, where using sera which have stood for some days, it is advisable to test such sera for auto-fixation of the complement before proceeding to the general test.

Neglect of these precautions has resulted in discarding some sixty tests; in one batch this was seemingly due to the presence in the antigen emulsion of a hæmolysin as shown by hæmolysis in the antigen control tubes. In another batch of test a therapeutic antidysenteric serum showed

auto-fixation of the complement; the same thing occurred with some of the patient's sera which had been in the laboratory for some days. All these tests had to be discarded. The rationale of these tests is the converse of the true Wassermann in which a known antigen is used in conjunction with an unknown serum.

In these tests the antigen—emulsions of unknown organisms—is unknown and is used in conjunction with known sera. The sera used were (*a*) antidysenteric (therapeutic), (*b*) sera from dysentery patients, (*c*) sera from enteric group patients, (*d*) serum from an individual who had not had enteric or dysentery and had not received typhoid inoculation.

TABLE VI.

Serum	Inoculations	Case	Dreyer's Method. Agglutination End-points						Remarks
			S	F	Y	T	A	B	
A	..	..	1/500	<1/250	1/1250	—	—	—	Polyvalent anti-dysenteric therapeutic serum
B	TV/2, 1915	Para B	*	*	*	1/2500	1/40	1/800	
C	TV/2, 1915	Para B	*	*	*	1/500	<8	1/50	
D	TAB, 6/16	Para B	*	*	*	1/400	1/250	1/800	
E	TV/2, 1915	Para A	*	*	*	1/250	1/5	1/5	Serum early in case. Para A isolated from blood
F	—	Normal	*	*	*	*	*	*	Not inoculated. Never had enteric or dysentery
G	*	Enteric group	*	*	*	1/800	1/500	1/2500	Pooled serum
H	*	Dysentery	<1/20	<1/250	<1/40	*	*	*	Serum of case in No. 10 Series
I	*	Dysentery	<1/20	<1/40	<1/40	*	*	*	Serum of Case 16 in series agglutinated homologous organism, 1—60
J	*	Enteric group	*	*	*	1/300	1/750	1/250	Pooled serum
	TAB, 1916	Dysentery	<1/25	<1/40	<1/40	1/12,500	1/50	>1/800	Homologous organism quite atypical, agglutinated by serum, 1—250
L	TAB, 1916	Dysentery	<1/20	<1/40	<1/40	1/2500	1/80	1/800	An organism isolated from case giving Flexner-Y sugars, agglutinated 1—126 with serum
M	—	Normal	—	—	—	—	—	—	Not inoculated. Never had enteric or dysentery

* Not known.

Captain Sladden has kindly provided most of these sera together with their agglutination titres as shown by Dreyer's method. In all cases the agglutinations of the antigen emulsions have been tested with specific

dysentery and enteric sera prior to the tests. Two groups may be distinguished on the agglutination. The first comprises the strains 1 to 7 in Series I which no longer showed the phenomenon of multiple agglutination in 1 in 300 dilutions of specific enteric sera.

The second group comprises the recently isolated strains 8 to 18 in Series II, in which the phenomenon of multiple agglutination was still well marked in dilutions of 1 in 300 specific sera. This distinction of two groups is made as it was supposed that fixation of the complement tests might show some relation between the phenomenon of multiple agglutination and enteric group agglutinins.

The object of these fixations of the complement tests was therefore twofold: First, to ascertain the relation of these strains to the dysentery group; second, to ascertain the relation of the phenomenon of multiple agglutination to the presence of homologous agglutinins in a serum.

In Table VI are shown the various sera used, their source and titres.

These are lettered alphabetically and referred to as lettered. In Table VII are shown the strains of organisms and their agglutinations prior to the tests.

TABLE VII.—Strains of Organisms used in Fixation of Complement Tests.

No. in series	Agglutination end-points with specific sera diluted 1/100 up prior to tests. Microscopic method					Remarks
	Shiga	Flexner-Y	Typhoid	Para A	Para B	
4	—	1/300	—	1/100	—	..
5	—	1/300	—	—	—	..
6	1/200	1/1200	1/300	1/200	1/200	Agglutinations with enteric group sera very feeble
7	—	1/600	1/200	1/100	1/100	Complete typhoid agglutination. 1/100; A and B feeble
10	—	1/600	1/600	—	—	Agglutination strong
13	—	1/1200	1/300	1/300	1/300	,, ,,
15	—	1/300	1/600	1/600	1/300	,, ,,
16	1/200	1/600	1/600	1/600	1/1200	,, ,,
Strain X	—	—	—	—	—	Proteus group used as a control antigen
18	—	1/1200	1/600	1/600	1/600	Agglutination strong

The several tests made are shown in the various tables which follow.

In Table VIII two dilutions of complement were used, in all the other tests three dilutions were used.

Before summarizing the results of the antigen tests in the preceding tables there are a few practical points of importance in reference to technique which may be outlined.

The method used throughout is similar in principle to the one used in Wassermann tests in the British venereal hospitals in France.

TABLE VIII.

Serum	Living Antigen — Serial number of antigen		
	4	6	7
Anti-dysenteric (therapeutic)—A..	++	++	± ±
Para B infection—B	++	+±	±−
Para B infection—C	± ±	∓ −	−

M.H.D. of complement .. 1—45.
Dilution in test .. .. 1—9 and 1—13.

TABLE IX.

Serum	Living Antigen — Serial number of antigen			Strain X
	4	6	7	
Anti-dysenteric (therapeutic)—A..	+++	+++	∓ ∓ ∓	−
Para B infection—D	−	−	−	−
Para A infection—E	−	−	−	−
Normal—F	−	−	−	−

M.H.D. of complement .. 1—45.
Dilution used .. .. 1—9, 1—12, and 1—14.

TABLE X.

Serum	Killed Antigen — Serial number of antigen			
	4	5	6	7
Anti-dysenteric(therapeutic)—A..	+++	+++	+++	+++
Enteric group—G	∓ ∓ ∓	−	+++	−
Para A—E	−	−	−	−
Normal—F	−	−	−	−

M.H.D. of complement .. 1—50.
Dilutions used .. .. 1—10, 1—12 1—14.

TABLE XI.

Serum	Killed Antigen — Serial number of antigen	
	10	13
Anti-dysenteric(therapeutic)—A..	+++	+++
Dysenteric, Case 10, Flexner type —H	+++	+++

M.H.D. of complement .. 1—40.
Dilution used .. .. 1—9, 1—11, 1—12.

TABLE XII.

Serum	Killed Antigen					
	Serial number of antigen					
	Strain X	10	13	15	16	18
Dysenteric, Case 16, Type atypical—I	—	+++	+++	+++	+++	Not tested
Enteric Group—J	—	+++	± ∓ Tr	+++	+++	,,
Dysentery, type atypical—K ..	Not tested	+++	Not tested	Not tested	+++	,,
Dysentery, type Flexner-Y—L ..	—	+++	+++	+++	+++	,,
Normal—M	—	—	—	—	—	—
Anti-dysenteric (therapeutic)—A..	—	+++	+++	+++	+++	+++

M.H.D. of complement .. 1—45.
Dilutions used .. .. 1—8, 1—10, 1—12.

Attention has already been drawn to the occasional presence in a living bacillary antigen of a hæmolysin; this appears to be eliminated by using emulsions which have been killed at 60° C.

One in five dilutions of fresh serum from dysentery or enteric group patients are quite satisfactory, but if such serum is kept at a room temperature (without special aseptic precautions) the serum becomes uncertain and may of itself deviate all complement used in the test proper.

It was found necessary in the case of therapeutic sera to use a dilution of 1/7 or 1/8, as a dilution of 1/5 occasionally brought about partial absorption of complement as shown by incomplete hæmolysis in the test control tubes; it is therefore very advisable to put up serum controls before proceeding to the general test, in which such controls are nevertheless included. In every case it is necessary to test the deviating power of the bacillary antigen; strong emulsions will completely deviate all the complement necessary for the tests proper.

Emulsion containing 4,000 million bacilli per cubic centimetre was found to be a useful average strength; the emulsions are made in saline from eighteen-hour agar slopes without the addition of an antiseptic.

Summary of Results of Complement Fixation Tests.

(A) Seventeen tests with antidysenteric serum gave: Fifteen complete positives; two incomplete.

(B) Twelve tests with sera from clinical cases of dysentery gave: Twelve complete positives.

(C) Twenty-four tests with enteric group sera gave: Five complete positives; six incomplete; thirteen negatives.

(D) Twelve tests with "normal" sera gave: Twelve negative.

(E) Nine tests made with an antigen of the proteus group against the above sera gave: nine negatives.

The nine strains tested therefore show almost complete uniform positive results with dysentery sera.

The dysentery sera and strains of organisms used in the tests may be summarized as follows (see Tables II, VI, and VII).

Dysentery Sera. Four Varieties (Table VI).

(1) A. Therapeutic antidysenteric agglutination Dreyer's standard emulsions.

(2) H. Clinical case of dysentery (Case 10 in Series) agglutination Dreyer's standard emulsions. Homologous organisms isolated Flexner-Y.

(3) L. Clinical case of dysentery. No agglutination of Dreyer's standard emulsions. Homologous organism isolated Flexner-Y, and was agglutinated by serum 1 in 125.

(4) I. and L. Clinical case of dysentery (serum 1 from Case 16 in Series).

No agglutination of Dreyer's standard emulsions. Homologous organisms isolated quite atypical and were agglutinated by sera.

In all cases the homologous organisms isolated showed the phenomenon of multiple agglutination.

The nine strains used as antigens fall into three groups on sugar fermentations.

(1) Flexner-Y. One strain (No. 10).

(2) Aberrant. Four strains (Nos. 4, 5, 6, and 7).

(3) Quite atypical. Four strains (Nos. 13, 15, 16 and 17).

With the exception of No. 5, all strains showed the phenomenon of multiple agglutination.

As regards the tests with the enteric group sera the result seems to depend to a great extent on the agglutinability of the strains and the titre of the serum; in view of the lack of complete uniformity of results in this respect no definite conclusions can be drawn from so few tests. It is to be noted that with one exception (Serum E, Table VI) the proof of enteric group infection in the cases providing the serum depended on agglutination curves complicated in most instances by triple enteric group inoculation. Serum E, although taken from a definite case of paratyphoid A infection which had received typhoid inoculation only, gave a low agglutination titre and all antigen tests with this serum were negative. Strain 5, which did not show the phenomenon of multiple agglutination, was the only strain that showed complete negative results with the enteric group sera. The provisional deductions are put forward that these agglutinable strains will deviate complement in the presence of homologous agglutinins and that such deviation—being proportionate to the degree of agglutinability of the organism and the titre of the agglutinins in the serum—is not a specific reaction other than an agglutination phenomenon. Further, if a known infective serum and a bacillary antigen giving agglu-

tination homologous to the infection, will deviate complement only in proportion to the agglutinability of the organism and the titre of the agglutinins, such deviation is not only no proof of the specificity of the antigen, but rather evidence to the contrary—since the presence or absence of agglutinins in an infective serum is no indication of the true antigen immune bodies in that serum. Compared to the tests with enteric group sera, all the antigen strains tested with dysentery sera give very clear-cut positive results—not only with known serum (antidysenteric) but with suspect sera (clinical cases). Three of the four clinical dysentery sera used did not agglutinate "standard" dysentery emulsions; the positive tests might, therefore, appear to be independent of dysentery agglutinins and to be a specific true antigen-immune body reaction, but these sera contained enteric group agglutinins and the antigen strains showed homologous enteric group agglutinability to which the positive results may possibly be due. It cannot therefore be claimed that these results are true antigen immune body reactions independent of dysentery agglutinins in the serum. For the same reason positive results with known dysentery serum (therapeutic) which showed high titre dysentery agglutinins only, may possibly be an antigen-agglutinin phenomenon and not a true antigen immune body reaction.

None of these antigen tests can therefore be said to establish the specificity of any of the antigen strains. All that can be said is that these strains give with enteric group sera complement fixation results which appear to be an antigen-agglutinin phenomenon, and that with dysentery sera they give positive results which cannot be accepted as true antigen-immune body reactions, in view of an antigen-agglutinin phenomenon which is superadded.

Immunity Experiments.

Two rabbits were immunized with Strains Nos. 6 and 10 respectively. The object of the experiment was to ascertain the specificity of the strains by the agglutinins produced by inoculation in the rabbit's serum. The toxicity of the organisms being unknown, very small doses were commenced with; this is very necessary with dysentery organisms, which are very toxic for rabbits.

Emulsions from eighteen-hour agar slopes were killed at 58° C. for half an hour on two successive days and carbolized. The inoculations were given subcutaneously at five-day intervals.

Rabbit 1.—Strain 6. (For agglutination see Table VII.) Inoculated 15, 30, 80, 200, 500, and 1,000 millions at five-day intervals. The rabbit was in no way disturbed by the injections.

Rabbit 2.—Strain 10. (For agglutinations see Table VII.) Inoculated 15, 100, 250, and 500 millions at five-day intervals. The rabbit was in no way disturbed by the injections.

The sera of the two rabbits on the second day after the last injection

were tested for agglutination by Dreyer's method, using "standard" typhoid and dysentery emulsions and emulsions of the antigens. The following Table XIII gives the agglutination end-points.

TABLE XIII.

	Antigen	T	Para A	Para B	S	F	Y
Rabbit 1, Strain 6 ..	Tr. 50	< 25	< 25	< 25	< 25	< 25	< 25
,, 2, ,, 10 ..	> 1.000	< 25	< 25	< 25	< 25	250	< 25

The result is very interesting.

In neither case has inoculation produced any enteric group agglutinins. Antigen Strain No. 6 has produced slight homologous agglutinins, but none for the typhoid or dysentery groups. This strain gave Gaertner fermentations, and was strongly agglutinated by specific Flexner-Y serum (Tables I and II). Antigen Strain No. 10 has produced strong homologous agglutinins and agglutinins for *B. dysenteriæ* Flexner of the same titre as the patient's serum from whom the strain was isolated.

This experiment is of particular interest, because the strain was equally agglutinated by specific typhoid and Flexner-Y serum (Tables I, II, and VII), and inoculation has produced no agglutinins for typhoid.

The conclusions from these two experiments are, therefore:—

(1) These strains are not related specificially to the enteric group.

(2) Enteric group agglutinability, as shown by these strains, is non-specific; the property is an acquired one.

(3) Strain 10 is a specific dysentery organism type Flexner, toxicity very slight.

(4) Strain 6 is probably non-specific, toxicity practically nil.

(5) The dysentery agglutinability of Strain 6 is probably non-specific, and the property is an acquired one.

The Phenomenon of Multiple Agglutination.

This was present in every strain except Nos. 5 and 9. Whether this phenomenon is common to particular strains of intestinal organisms under certain conditions cannot be stated. In this series multiple agglutinability was only tested on those strains which in the first instance agglutinated with specific dysentery sera; it has therefore yet to be shown whether this phenomenon is found in any conditions not associated with dysentery. Every case, where inquiries were made, had received typhoid inoculation; it is almost certain that the majority had also received the triple inoculation which has now been in use for more than a year. It is therefore suggested that this phenomenon, so far as the enteric group agglutinations are concerned—whatever its significance may be—is closely

associated with, if not actually due to, typhoid inoculation. No explanation is offered, but it is suggested that certain strains of intestinal organisms, whether specific or not, are capable in inoculated individuals of being rendered agglutinable under the influence of the antibodies produced by the inoculation.

Until further observations have been made, there is no proof yet available that the majority of the strains of organism in this paper belong to the *B. dysenteriæ* group. It is true they agglutinate more strongly with specific dysentery sera in the majority of cases than they do with specific enteric group sera, and that this agglutinability persists while that for specific enteric sera disappears. Beyond this no further claim can be made for those strains which do not conform to well-established fermentation tests. The same suggestion which has been offered for the phenomenon of multiple agglutination with the enteric group holds also with the dysentery group, except that, in the latter case, the phenomenon is due to infection with a specific organism, and not due to inoculation.

That these atypical strains are not *B. dysenteriæ*, but intestinal organisms sensitized and rendered agglutinable to specific dysentery sera is supported by the facts that :—

(1) The strains were isolated in every instance from cases with a clinical history of dysentery.

(2) They were isolated in the vast majority of cases from individuals passing normal stools, and in many instances seemingly fit—conditions contrary to general experience.

(3) The fermentation tests are in many cases unrelated.

(4) One strain (No. 10, Table I) agglutinated equally well with typhoid serum, two strains (Nos. 15 and 16, Table I) gave stronger enteric group agglutinations than they did dysentery.

(5) Immunization of a rabbit with an atypical agglutinable strain produces no specific agglutinins.

All strains showing multiple enteric group agglutination were associated with high enteric group agglutinins in the homologous sera, but not in all cases did the sera contain agglutinins for standard dysentery emulsions. That is to say the homologous serum of strains which showed agglutination with specific dysentery sera in some instances gave no agglutination with specific dysentery organisms. If one were dealing with known typical dysentery strains, this factor is of no importance, because specific organisms agglutinating with specific sera are generally present in the infection some time before homologous agglutinins appear. If, then, these atypical strains here described are to be excluded from the *B. dysenteriæ*, and if their agglutinability with specific dysentery sera is to be explained on the grounds previously suggested, then it must be presumed that this agglutinability as a phenomenon is not due to the agglutinins in the serum of the infective person, but to some other factor in the infective process.

The Fermentation Reactions.

The behaviour of the sugars with these organisms is extraordinarily varied. Even the lactose fermenters do not conform to any special type of intestinal organism. It seems unreasonable to suggest that in a comparatively small number of cases so many different strains should be present all of which possess certain similar specific characters.

Two possibilities therefore suggest themselves; either the atypical strains are specific organisms which have acquired atypical fermentation characters, or they are non-specific organisms of the intestinal tract which have acquired certain specific properties and fermentation characters atypical of any well-defined non-specific group. All the atypical non-lactose fermenting strains conform in other cultural respects to *B. dysenteriæ*, they do not liquefy gelatine, they are non-motile Gram-negative bacilli and give the characteristic milk reactions of the group—early acid followed by alkalinity. Two of these strains give the fermentations of the Gaertner group but do not agglutinate with specific Gaertner serum. Sugar fermentation tests have been repeated with most of these strains—in some instances six weeks after first isolation; as far as these tests have gone there has been no reversion.

General Cultural Properties.

All the strains except Nos. 4 and 5 grew readily on ordinary media; confluent colonies form a moist, rather slimy growth which shows no tendency to spread beyond the area inoculated. Of the early strains all except Nos. 4 and 5, which have died out, are still alive after more than two months at room temperature during the winter.

General Summary.

Two hundred and sixty-three stools were examined for dysentery and gave fifty-eight positive results on agglutination tests only.

TABLE XIV.

Stools examined	Dysentery. Agglutinable growths	Agglutinable strains isolated	
		Non-lactose fermenting	Lactose fermenting
Series I—143 ..	31	7 { 3 Flexner-Y type / 4 Aberrant }	Not sought
„ II—120 ..	27	6 { 4 Flexner-Y type / 2 Aberrant }	5
Total 263 ..	58	13	5

All the strains isolated showed, with two exceptions, the phenomenon of "multiple agglutination."

This phenomenon is regarded as a non-specific feature of these organisms as regards the enteric group for the following reasons:—

(*a*) The patients were not suffering from enteric group infection as understood.

(*b*) Agglutination with specific enteric group sera occurred with several sera of the group, did not occur in most instances in high dilution and tended to disappear early (Table I).

(*c*) Complement fixation tests with enteric group sera gave no proof of specificity, the positive and incomplete tests seem to depend on agglutination factors and are regarded as an antigen agglutinin phenomenon and not a true antigen immune body reaction (Tables VIII to XII).

(*d*) Immunity experiments with two strains produced no enteric group agglutinins in the rabbits inoculated.

In all cases investigated multiple agglutination was associated with high titre enteric group agglutinins in the homologous sera of individuals who had received triple typhoid inoculation. It is therefore considered that this phenomenon is not a specific peculiarity of any particular strain or group, but rather the resultant of some factor such as inoculation.

Most importance should be given to those considerations which bear on the practical side of the dysentery question, as affecting the forces in France. Whether a particular infection is or is not due to a true *B. dysenteriæ* is of importance. In acute or active cases of dysentery, it is important for epidemiological reasons to know if the infective agent is of a particular strain. Infective localities can be mapped and the spread of epidemics can be followed and anticipated with the aid of the laboratory. Of almost greater importance possibly is the carrier question. An active case of dysentery is infective during the active stage and needs no laboratory evidence to support the obvious clinical condition. But when a case of dysentery has recovered and is physically fit for duty, accurate bacteriological diagnosis is of first importance, for the disposal of that individual depends on the laboratory findings. It is very important that no carrier be set free to aid as a new focus for the infection of others, it is also important that all "healthy" men be returned to duty as soon as possible. It is not claimed in this paper that the atypical strains described are dysentery organisms. Possibly they may be recognized types which have been modified by various extraneous conditions, or new strains which have so far escaped notice; that this is possible has not been disproved.

From a practical point of view it is considered that the question of whether these dysentery agglutinable strains are or are not *B. dysenteriæ* is not of paramount importance in the early diagnosis of the disease where a diagnosis can be made on clinical grounds. But an accurate bacteriological diagnosis is required for the diagnosis of carriers.

At this Base where the agglutination from plate method has been largely used for the diagnosis of dysentery, it has been noticeable that positive results with this method are relatively infrequent during the acute stage of the disease, but become frequent when patients become convalescent. This corresponds with what has been noted early in this paper,

that agglutinable strains were present in cases the majority of whom were passing normal motions.

As pointed out before, isolation of true *B. dysenteriæ*, once the motions have become normal, is infrequent.

It may possibly be urged that all cases from which atypical dysentery organisms have been isolated should be regarded as potential carriers. It has been pointed out that in the second series of 120 cases, 11 agglutinable strains were recovered from 27 plates which gave agglutination. The other sixteen plates were subcultured direct from the plate and from the emulsions with which the agglutination tests were made, but no agglutinable colonies or growths were found in subcultures. It is therefore suggested that the failure to find agglutinable strains in subculture was not due to failure to isolate the original strain, but to loss in subculture of agglutinable properties on lines precisely analogous to what has been found with the enteric group agglutinability of the strains described.

Analysis of Table XIV gives the following figures :—

	Per cent
(1) Total positive cases returned on agglutination tests only..	21·67
(2) Total agglutinable strains isolated (series No. 2 only)	9·16
(3) Total non-lactose fermenting agglutinable strains isolated ..	4·94
(4) Total typical *B. dysenteriæ* isolated	3·04

The laboratory returns therefore show a jump from 3·04 per cent to 21·67 per cent according to the various standards of what is regarded as specificity.

It has been shown that agglutinability can be a phenomenon of no specific importance, and it is suggested that this property may be acquired by non-specific organisms as the result of specific infection.

One atypical strain has been shown by an immunity experiment to be probably non-specific. The probability is that the atypical strains are all non-specific; it is possible that the only specific property they possess—agglutinability with specific sera—is an acquired one and no proof of specificity.

The conclusions therefore are :—

(1) Agglutinability alone provides no proof of the specificity of an agglutinable organism which does not conform to cultural tests.

(2) Diagnosis dependent on agglutination tests only is not applicable to carriers for the reason that a large number of positives will be returned on totally inadequate bacteriological grounds.

(3) Should the suggestion that the agglutinability of heterologous bacteria affords proof of specific infection be confirmed and controlled by further observations, it may become possible to diagnose infection from the examination of bacteria in mixture from plate cultures.

PYREXIAS OF DOUBTFUL ORIGIN IN AN INFANTRY BATTALION ON ACTIVE SERVICE.

By the late Captain C. K. McKERROW, M.B.
Royal Army Medical Corps.
Medical Officer of —— Battalion, Northumberland Fusiliers

with a

FOREWORD

By Colonel R. J. BLACKHAM, C.I.E., D.S.O.
Army Medical Service.
A.D.M.S. —— Division.

FOREWORD.

A melancholy interest attached to this paper as it was read before a Division Medical Society by the author a short time before his death.

Had the author lived it would have been submitted as his thesis for the degree of Doctor of Medicine, Cambridge University. At the time when he was wounded Captain McKerrow was actually making a fair copy from the rough notes from which he read before the Divisional Medical Society, and his widow has completed the paper from these notes. Dates and names of persons and places only have been omitted.

Leaving his wife and his practice at the beginning of the War, he became the Regimental Medical Officer of a famous Fusilier Regiment and rapidly made himself a power in the battalion.

His quick brain soon adapted itself to military methods and he became a part of our great national military system, but becoming a soldier he did not cease to be a doctor, and he saw that even work with a battalion in the field gave facilities for what must, for want of a better term, be called "clinical work."

His study of obscure fever cases during the scanty leisure of the medical officer of a battalion which has been fighting almost continuously for a year and a half reveals the possibility of medical study even in the front line trenches.

Captain McKerrow's work is not only a valuable contribution to medical literature but an inspiring example to other medical officers of the possibility of using the clinical material constantly passing through their regimental aid-posts and medical inspection rooms.

Captain McKerrow was mortally wounded in action. His study of clinical work with a battalion on active service will remain as a memorial of a very gallant soldier and a truly skilled physician.

R. J. Blackham, *Colonel,*
A.D.M.S. —— Division.

THERE has been much speculation during the past year as to the nature of those pyrexial illnesses, which form so large a proportion of the total morbidity of the British Army in France and Belgium and in which the origin of the pyrexia is obscure. The literature on the subject has been extensive and has disclosed the great differences of opinion that exists amongst those who are brought into contact with such cases. The base hospitals, the casualty clearing stations and field ambulances have each published interesting observations based on their personal experiences of such pyrexias. The regimental medical officer has alone been silent. It is a generally accepted opinion that the nature of the conditions under which these officers work renders clinical observation or accurate records impossible. Such is really not the case nowadays whatever it may have been formerly. Time and opportunity for studying his cases are abundant and he has the unique advantage of being able as a rule to follow through many months the subsequent careers of his patients. This seems to me sufficient reason that he also should add his contribution to the discussion.

The records which I have kept include all illnesses which occurred in the —— Northumberland Fusiliers, since coming to France on August —, 1915, and which were of sufficient importance to make a man "go sick." The chief symptoms of each case were noted and its subsequent course followed as far as possible. When a man was evacuated to hospital and did not rejoin the unit some details of his illness were often obtainable from himself and from his friends. Men were visited when in hospital whenever circumstances permitted. Men who were kept with the unit were generally kept in the aid-post under constant observation till a definite opinion was formed of their illness. The great improvement in our aid-posts during the latter part of this year has rendered this more and more possible.

These records show that during the fifteen months from September, 1915, to December, 1916, there were 365 cases of pyrexia in the battalion for which no definite cause could be found. This leads naturally to the question as to what is to be considered the dividing line between causes which are definite and those that are indefinite. The cause of the pyrexia in a case of typhoid, of tonsillitis, or of pneumonia, is sufficiently obvious and will cause no argument, being referred respectively to the entry of toxins into the blood from the intestine, the throat or the lung. It is the less definite cases which render judgment difficult. Suppose a man develops a slight cough and a rise of temperature. Are we to consider his cough as sufficient reason for condemning his nasopharynx as the focus from which the temperature-raising toxins spread? Some might consider it equally reasonable to regard the pyrexia as the cause of the cough. I have consequently been compelled to include in my series many cases in which greater facilities or knowledge would possibly have produced a more exact diagnosis. I have excluded all cases where the cause of the pyrexia was at all probable, such as marked nasopharyngeal, bronchial or intestinal infections.

The total number of really doubtful cases which occurred in the battalion during fifteen months was 365; of these 210 were treated entirely with the unit, and 155 were sent at some period of their illnesses into the field ambulance; of the latter 52 have never rejoined. This as a rule means that the man had been evacuated out of the divisional area owing to the obstinacy of his illness. This does not hold good during very active operations when men are readily drafted to other units. It has been in most instances possible to obtain some records of the course of the illnesses from which these men suffered, but much reliance cannot be placed on them.

The cases which are labelled P.U.O., N.Y.D., influenza or trench fever form at present a large proportion of the sick of most divisions. There seems every reason to believe that such labels cover a variety of infections. The only possible way of separating one from another without the aid of the bacteriologist is to group the cases according to their symptoms and their natural history. The records I have kept are in many respects deficient but they give the main symptoms of each case both at its onset and during its course. The results of the illness on the man's subsequent health have been observable generally for many months.

The first point to consider is how do these cases start.

The symptoms are in my experience separable into four groups.

The first group consists of men who complain of pains all over. They often say that they feel as if they had been beaten. They generally have a frontal headache, but it is seldom very severe. The pain is usually most severe in the back, the glutei, the neck and the thighs. It is referred definitely to the muscles and they are tender when firmly pressed. There is often slight constipation which responds readily to treatment. The face is generally flushed, the eyes dull and the tongue slightly furred. The temperature in the mouth is usually above 101° F. and often above 103° F. In sixty per cent of my cases with such general muscular pains there was some congestion of the fauces and a slight cough. In twenty-four per cent there was some purulent nasal discharge and in four per cent there was slight herpes labialis.

The men always say that their attack came on suddenly. A very common complaint is that they suddenly "went cold." I have seen one case starting with a slight rigor.

C. T., a stretcher-bearer, started to take a man to the field ambulance which was half a mile away. He was feeling quite well. Before he had one halfway he felt very cold and shivering, so came straight back. He was pale and had a slight rigor. His temperature was 103° F. He had slight congestion of the fauces with a short infrequent cough. He complained of great pain across his lumbar muscles and in the thighs. He had a frontal headache, but it was not severe. He said that his throat had not felt sore and that the cough did not trouble him.

This is a very typical case of the first mode of onset. There were 166 cases of this type, that is, forty-five per cent.

The second class comprises the men who come to sick parade complaining of their legs. They sometimes have a headache which is generally frontal when present and occasionally is severe. Nasopharyngeal symptoms are generally absent, but about ten per cent have a slight cough. There is sometimes constipation, but it is unusual. Four per cent of my cases had slight diarrhœa. As a rule these men are pale and look as if they were in pain. The temperature is generally below 102° F. when the man first comes sick. In many cases it is below 100° F. Daily fluctuations are usual, and a man who comes sick with a temperature of 99° F. in the morning has not uncommonly a temperature of 102° F. by the evening. Some cases show a normal temperature in the earlier part of the day which may lead to mistakes unless the evening temperature is also taken. In a few cases the temperature is highest in the morning. The pains complained of in the legs are very typical. One man said that it felt as if his shin bones were being scraped with a knife. Pressure over the tibiæ is acutely painful at certain spots, a very common one being about four inches above the ankle joint. As a rule, both legs are equally tender at the onset. In three per cent of my cases with shin-pains there was also great tenderness to pressure over the lower end of the femur in the region of the adductor tubercle, and in two per cent at the origins of the gastrocnemii.

The pains always get worse at night. The men say that as soon as they get warm in bed the pains increase. I have never seen any outward change in the painful parts.

The onset of these cases seems somewhat variable. I have seen cases start with great suddenness. My sick corporal was perfectly well at 7 a.m. At 9 a.m. he had severe pains in his shins and head. His temperature was 100° F. by the mouth. By the evening the pains in his legs were almost unbearable, and his temperature was 102° F.

On the other hand, some cases start gradually. Cpl. D., of D Company, came to sick parade on August 16 complaining of pains in his shins, which he had had three days. He had a slight headache. His temperature was 99° F., and he was excused duty. He did not go sick again till the 26th, when he came with the same complaint and a temperature of 101° F. He was sent into hospital, and was away three weeks. He had a relapse while there. Some men come to sick parade complaining of shin-pains, but show no rise of temperature at any time of the day. These cases do not come under the heading of pyrexias of uncertain origin, but they are of interest as suggesting that there is an apyrexial form of this type of case.

In my series there were 132 men whose chief complaint was the pain in their shins, that is to say, thirty-six per cent of the total number of cases.

The third type of case complains of his head, and his head only. This is so common a complaint in all pyrexias that this group probably includes a variety of illnesses. About 40 per cent of these cases show some slight nasopharyngeal congestion, and some develop general muscular pains; 14 per cent developed definite shin-pains; 16 per cent were sent into hospital,

and did not return. The remaining thirty per cent cleared up rapidly, and gave no clue to their nature. The headache complained of is generally frontal, and in some cases was very severe, especially in those men who later had shin pains. The pyrexia is generally moderate, and the onset of most of the cases was sudden.

The number of cases of this type was fifty-five, that is fifteen per cent.

The fourth class of case complains of weakness. When he first comes sick, he has no pains of any description. The temperature is generally below 100° F., and the man looks pale and tired. He generally says that his illness started gradually. There were only thirteen of these cases, that is, 3·5 per cent, but a point of interest about them is that eight developed shin pains, and were evacuated. The other five had no definite symptoms except weakness, and cleared up satisfactorily. If there is such a thing as the pyrexia of exhaustion, these five cases might be regarded as suffering from it, for they all occurred immediately after a period of great strain.

Such are the four types of onset of these cases according to my experience. What course do they run? As I mentioned previously, 210 out of my series of 365 cases, that is, 57 per cent, were treated entirely with the unit. Those who know the conditions of life with an infantry battalion will realize that this means that fifty-seven per cent of men suffering from pyrexias of uncertain origin recover rapidly, and, at any rate, sufficiently to "carry on."

But the proportion of rapid recoveries is even greater, for of the 155 men who were sent into hospital, forty-six rejoined their unit within fourteen days.

These are often cases which have to be evacuated owing to military reasons such as active operations or reliefs. We find, therefore, in this series of cases that seventy per cent recovered rapidly, and thirty per cent proved more obstinate.

The treatment of all the cases was essentially the same. Salicylates were administered in ten-grain doses every four hours, a purge, if necessary, no food, but lots of hot water. This was persisted in for twenty-four hours. If there was no improvement, then the man was sent into the field ambulance.

The manner in which the different types of case react to such treatment is interesting. Of the first type, the men who have general muscular pains, and often a slight cough and headache, 138, that is, 83 per cent, recovered rapidly and completely; 20 cases, that is, 12 per cent, were in hospital some time, or did not return to us; 5 per cent returned from hospital, but had relapses.

Of the second type, the men with shin-pains, only 15 cases, that is, 11 per cent, recovered rapidly and completely; 64, or 48 per cent, were long periods in hospital, or did not return to us. In more than half of these, there were reported to have been relapses. Fifty-three cases, that is, forty-one per cent, had definitely observed relapses while with the unit. Some

of these occurred after the men returned from hospital. Several men had two or more of these relapses, and one man was sent into hospital three times in a month.

Of the third type, men with headache and pyrexia, seventy per cent cleared up rapidly and completely; sixteen per cent went into hospital, and did not return. It is known that several of these recovered rapidly, but were drafted to other units; fourteen per cent developed pains in their shins, and had relapses.

The fourth type, men complaining only of weakness, form a small proportion—1·5 per cent of the whole series. There were thirteen cases in all; five of these cleared up quickly and completely with rest. The remaining eight were sent into hospital, and two did not return. The other six all developed pains in their shins, and proved remarkably obstinate, having several relapses.

The conclusion which this analysis of the history of these cases suggests is that the obstinate case is essentially the one in which shin-pains occur at some period of the illness. Of 146 cases of this type only fifteen, or ten per cent, proved easily curable. On the other hand, the man with general muscular pains, a fairly high temperature, often a cough, and generally a headache, appears to respond well to treatment. Nearly ninety per cent of these cases rapidly and completely recovered.

There are other essentials in which the shin-pain type of case appears to differ from the others. One is in their reaction to salicylates. It is often found that the man with general muscular pains is greatly relieved by even ten grains of salicylate of soda or aspirin. As a rule, he perspires freely, and his temperature falls. The man with severe pains in his shins will often find no relief at all from doses many times larger. Another point is that such cases do not in my experience perspire, nor does the temperature fall even after 40, 60, or 80 grains have been given.

Another characteristic of the case with shin-pains is its liability to relapse. The man appears very much better, the pains disappear to a great extent, the temperature falls, and then quite suddenly all the symptoms return, often with increased intensity. Before this tendency to relapse was realized, the field ambulance incurred much undeserved abuse. Men were constantly being returned to their units as cured, and then showed a temperature of 100° F. the same night or the next morning with a return of their pains.

In my series there were 68 men who had recurrences, several more than one. Of the 68, 53, that is, 78 per cent, were men who had definite shin-pains at the commencement of their illness; 6, that is about 9 per cent, who, though they "went sick" with some other complaint, developed such pains later. This means that eighty-seven per cent of men with known recurrences were men who suffered from pains in their shins. The remaining thirteen per cent were men who complained of general muscular pains, weakness, or headache, but did not have any definite shin-pain.

The proportion of each class of case, which relapse is difficult to decide very exactly owing to the fact that a coherent account of a man's illness in hospital is hard to obtain. In my series forty-seven per cent of all cases with shin-pains, but only five per cent of the men with general muscular pains, were known to have recurrences.

A small proportion of my cases had general muscular pains combined with severe pains in the shins. In these the general pains preceded the shin-pains generally by at least a day. These men generally said that their illness had "settled in their legs."

Serjt. B. came sick on November 16 with severe pains in his head, back and thighs. He had a slight cough with some faucial congestion. His temperature was 102·4° F. We were moving the same day into the line so he was sent into hospital. This was apparently a case which would be expected to recover quickly. He was sent back to the unit on December 3. He said he had no pains but felt rather weak. Next day he came sick complaining of pains in his shins. There was marked tenderness down each tibia. His temperature was 100° F. in the mouth. He was kept in the aid-post for three days and treated with salicylates. Neither the pains nor his pyrexia were much relieved and he was again sent into hospital, where he now is.

Such cases seem to combine general muscular pains with shin-pains and recurrence. In my experience they are uncommon, as only five per cent of the 166 cases, where the original complaint was general muscular pains, later developed shin-pains.

The conclusions which these clinical facts suggest are :—

Firstly.—That cases of pyrexia of doubtful origin occurred very commonly amongst the men of the unit we are considering during fifteen months in France and Belgium.

Secondly.—That almost two-thirds of such cases were never evacuated and that about three-fourths of such cases clear up rapidly and completely.

Thirdly.—That the cases which prove obstinate are, as a rule, those of men with pains in their shins.

Fourthly.—That such shin-pain cases show definite characteristics both in their tendency to relapse and in their response to treatment.

The incidence of these cases in the battalion both as regards time and place is also of interest. To study this it is necessary to give a short diary of the movements of the battalion during its fifteen months on the Western Front.

The battalion came to France at the end of August, 1915. The weather was hot and dusty. Flies were plentiful. On September 10 we went into trenches at P— for instructions with the ——.

During September, there were four cases of P.U.O., all of the general muscular type. One was in hospital a week. The others were treated with the unit.

In October, we took over the trenches at O—. The first three weeks

of the month were very wet and the trenches became rapidly waterlogged. There were not sufficient gum-boots and the men felt the cold and damp very much. In spite of this their health was remarkably good. There were six cases of P.U.O. Two were sent to hospital labelled as influenza. One came back quite well in ten days. The other developed bronchitis, was sent to England and eventually drafted to another unit. The other four were only ill for three or four days and did not leave the battalion. The chief complaints at that time were boils, lice, scabies and impetigo.

November, December and January were very wet indeed. The natives said they had not seen such rain for years. The River —— was in fuller flood than for thirty years. The trenches were knee deep in mud and water. Most of the dug-outs fell in. The men were in trenches twenty-two days in each month and there were constant and heavy working parties.

During these three months there were only twenty-three cases of P.U.O. in the unit. There were several cases of acute bronchitis, pleurisy and chronic rheumatism. Of the twenty-three P.U.O's. thirteen were sent to hospital. They all returned in periods varying from four days to four weeks and remained quite well after their return. One of the cases had pains not unlike the shin-pain type. He rejoined the unit in ten days and has remained well since. The ten cases treated with the unit all cleared up in a few days.

February was rather drier but very cold. There were nine cases of P.U.O., all with general muscular pains, six were sent into hospital. All rejoined the unit within two weeks and remained well. The three men treated with the unit cleared up rapidly.

On February —— the battalion moved back. We had a heavy march of twenty-three miles in the snow. Two of the P.U.O. cases with general pains occurred the following day.

March was very cold but fairly dry. Till the —— we were in back area round Q— and ——. During this period we had seven cases of P.U.O.

They all had general muscular pains. None were sent to hospital. On the —— the battalion took over trenches at Z—. The trenches were very good but the sanitary condition of the town itself was very bad. There were three cases of P.U.O. from the 19th to the end of the month. Two had pains all over and one complained of weakness alone. One was in hospital four days. They all recovered quickly and had no relapses.

April was wet but warm. We were in trenches off and on till the 17th. During this period there were six cases of P.U.O. Four of these were men with general pains; one had pains in the legs only and one complained only of weakness. The latter was sent into hospital and has not returned. The others, including the man with leg pains, cleared up rapidly. The leg pains were definitely referred to the shins and were worse at night. This was the first case of the kind I had seen in the battalion. I thought at the time that the condition might be specific and tried large doses of potassium iodide with no effect. I also tested this and many subsequent cases for ataxia but found no signs of it. The knee-jerks were also normal.

The latter part of the month was spent in S—. During this period we had sixteen cases of P.U.O. Eight of these were men with general muscular pains and eight had pains only in their shins. Seven of the eight general pain cases were at duty in two days. The eighth developed shin-pains and was evacuated. He returned in five days as cured. Two days later his temperature was 100° F. and his pains were worse. This was the first relapse that I had seen.

The 8 cases who originally complained of pains in their shins comprised 4 who went to hospital and 4 who were cured with the unit. Of the former 1 did not return, 2 were away for several months and 1 came back in a week but had a severe relapse. On the 22nd of this month a case of paratyphoid was sent into hospital. This is the only diagnosed case of an enteric group infection which has occurred in fifteen months in this battalion.

On April 24 about half the men were inoculated fully with T.A.B.

April is of special interest as providing the first definite cases with shin-pains and with relapses. Another point of interest is that of the eight men who complained of shin-pains five were in No. 14 platoon. One occurred on the 25th, one on the 27th, and three on the 28th.

May was on the whole a dry month. We were in the back area round T— till the 18th. We then moved into trenches at V—. They were very dirty and offensive. There were 16 cases of P.U.O. in May, and 15 of these occurred while we were in the back area; 9 of the 16 were men with general pains, 8 of these cleared up in a few days. One was sent to hospital and did not return. Three men complained only of headaches. One cleared up quickly. One was sent into hospital and did not return. One developed shin-pains and was also evacuated.

Of the four others three had very definite shin pains. One was sent to hospital and did not return. One had very severe shin pains but only showed pyrexia for one day. He was treated with the unit but attended sick parade for about three weeks. My corporal thought the pains were due to the man having overtrained when a civilian. He had been a professional footballer.

One man had a definite recurrence with pyrexia and pains three days after returning to duty.

June was a good month. On the 3rd we left V— and were in the back area at U— till we moved to Y— at the end of the month.

The men were in good billets with lots of rest and were not overworked. There were, however, thirty-one cases of P.U.O. They were evenly distributed as regards date of occurrence, but not as regards distribution in the battalion. Four were in A Company and 4 in C, but there were 10 in B and 13 in D.

Nine men were sent to hospital and only two returned. One of these had a very definite relapse three days after coming back. Of the 22 men treated with the unit 18 were well within 3 days. In none had shin-pains

been complained of. The other 4 comprised 3 men with definite shin-pains and 1 with weakness. All of these had recurrences and the latter developed shin-pains.

For the whole of July we were in Y— area. The weather was very wet at the beginning of the month but improved later. From the 3rd till the 19th the battalion was very actively engaged. There were 33 cases of P.U.O. in July, and of these only 9 were in the first half of the month; of these 9, 7 were men in the general muscular pain type. Two were sent into hospital and were drafted to other units. The others cleared up rapidly.

Of the twenty-four cases in the last half of the month there were only two with general muscular pains. Eleven complained of shin-pains only, six of headache and five of weakness.

There were 6 cases with definite relapses, 5 were shin-pain cases and 1 a weakness case. Three men with weakness and one with shin-pains were sent to hospital and did not return.

There did not seem to be any grouping of the cases according to platoons in July. There were a great number of men complaining of pains in their shins at the end of the month but only a small proportion of these "went sick."

The month of August was warm and bright; we were at Y—till the 7th, when we came out of the line and moved north to X—, where we were for the last two weeks of the month. There were 38 cases of P.U.O., 17 with definite shin-pains, 8 with headaches, 2 with weakness and the remainder with general muscular pains. Of the 17 shin-pain cases, 11 had marked relapses, 5 were sent to hospital and did not return. One cleared up easily. Of the headache cases three had recurrences and three were sent into hospital and have not returned. One weakness case cleared up rapidly, the other developed shin-pains and was evacuated.

This month is of interest for three things:—

The first was the occurrence of seven of the most obstinate cases I have seen. One man was in hospital on three separate occasions, and the others twice.

The second was the association of shin-pains with rather profuse diarrhœa in three men and with cystitis in two.

This may have been accidental.

The third, and this seems to me of special interest, was the sudden appearance of this shin-pain type of illness in the H. Q. Company. There had been no cases amongst them up to this. It must be remembered that as a rule their conditions are better than those of the men in the line, but on the —— their conditions were as bad and sometimes worse.

On August 1, one of the H. Q. orderlies had a definite attack of shin-pains with pyrexia. He was not very bad and was kept with the unit. He had a very marked relapse on the 21st.

On August 17 one of the H. Q. signallers developed shin-pains. He was sent into hospital.

On August 26 the Colonel's observer was attacked. He had very severe shin-pains but remained with the unit as he was very anxious to do so. He had, however, two relapses, and had to be sent to hospital.

On the same day, the 26th, another H. Q. signaller went sick with pyrexia and shin-pains. He recovered quickly and was never very bad.

On the 29th the signalling corporal was attacked.

He could scarcely walk and could not sleep at night, owing to the pains in his shins. He recovered fairly quickly but had one relapse.

On the 31st another signaller was down with the same symptoms. He was laid up for two days with shin-pains and pyrexia, got apparently well, and then on September 11 had a definite relapse.

These cases seem to me of great interest because they appear to suggest very strongly the communicability of the disease. It is also possible that the telephone instruments may have carried the infection from signaller to signaller. This is of course mere conjecture.

September was a good month. On the 4th we left X— and returned to Y—. There were forty-one cases of P.U.O., of these twenty-six were men with shin-pains. Twelve of these had known recurrences. There were three cases in which shin-pains were associated with diarrhœa. All the cases without shin-pains, fifteen in number, were of the general muscular type.

Of the total number of P.U.O. cases this month twenty-two were in D Company. On the 21st of the month an officer was evacuated with dysentery. This was diagnosed later as a Flexner bacillus infection.

October was on the whole fine and fairly warm. We were at Y— till the 9th, when we moved north and took over trenches in the W—. These trenches were very wet and muddy towards the end of the month.

During October there were 71 cases of P.U.O., and 52 of these were men with shin-pains of varying severity. There were 19 cases of general muscular pain with slight coughs. All but one of these occurred during the last ten days of the month.

Thirty-seven men were sent to hospital and nineteen have not returned. Eleven of the nineteen were of the shin-pain type.

There were twenty known recurrences and eighteen of these were in men with shin-pains. The other two were cases with general muscular pains.

The distribution of the cases is again of interest.

There were 15 shin-pain cases in D Company, 6 had recurrences. In A Company there were 25 cases and 20 of these were in 2 platoons.

Headquarters Company was again attacked but on this occasion the infection was less severe except in the case of the sick corporal.

On the 3rd one of the H. Q. orderlies was sent to hospital with pyrexia and pains in his legs. The pains seemed rather in the muscles than in the bones.

On the 10th another orderly followed him, and on the 13th the sick corporal was attacked. He had very severe shin-pains and has had three relapses. On the 20th one of the observers went sick, and on the 26th another orderly. On the 31st yet another orderly was attacked. All

the men except my sick corporal recovered rapidly, and in none of them did shin-pains cause much complaint.

An interesting fact was that three days after my sick corporal was attacked his greatest friend, C. S. M., of A Company, was seized with an exactly similar illness. He had severe shin-pains and had two relapses. These two men were constantly together and their simultaneous infection seems more than a coincidence.

In November we were off and on in trenches all month. There was a good deal of rain and some trenches were much waterlogged.

There were 62 cases of P.U.O. of these 21 have been shin-pain cases. A point of interest is that of the 21 men with shin-pains 15, or 75 per cent, are men who have suffered in the same way during spring and summer. That is to say that during November there were only 6 fresh cases of the shin-pain type.

Of the forty-one men without shin-pains all except two were men complaining of general muscular pains and slight coughs, in fact what one before the war would have called influenza.

Thirty-four men have been sent into hospital with this general muscular type of illness and most of them have returned. There have been no recurrences.

Such are the facts of my experiences of P.U.O. during fifteen months in France and Belgium. I realize very clearly the many deficiencies of my clinical records, but the possibility of following the histories of many cases for several months, sometimes a year or longer, lends a certain value to them.

The points which seem of interest are these :—

First.—The Battalion came to France in very hot weather. Their sanitary zeal was slight and flies were very prevalent. In spite of this there was no outbreak of any form of pyrexial illness. There were sporadic cases, of what are for want of a better name called influenza. The symptoms consisted of general muscular pains with often a slight cough. During the winter months, although the weather was bad, trenches were wet and men hard-worked, the health of the battalion was good. Such cases of pyrexia that occurred and showed no definite cause were all of the general muscular type.

Second.—At the end of February the battalion moved and was in the back area till March —— when it took over a new line at Z—. The trenches were good and dry but the sanitary condition of the neighbourhood was bad. The weather was much warmer towards the end of the month. Flies appeared in numbers. In the first half of April the men were in trenches and there were six cases of pyrexia with general pains. In the last half of the month the men were in rest and there were 16 cases of pyrexia, 8 with general pains but 8 complaining of a condition I had not heard of till then in the unit, namely, severe pains in the shins. The pains were so severe as to suggest to me the lightning pains of tabes. About the end of April our only diagnosed cases of para-typhoid occurred.

Third.—These cases of shin-pains became increasingly common and another characteristic, their tendency to relapse, was noticed. It was also noticed that they tended to occur in groups amongst men who were much together. They also came in waves as regards time. For a fortnight there might be only 1 or 2 and then in the following week there might be 20. Whether the men were in or out of trenches seemed to make no difference. All during the summer and autumn these cases occurred, reaching a maximum in October, when they caused a morbidity of nine per cent. The unit was very actively employed in July and September; shortly after each period of increased activity there was an outbreak of this type of illness. It was not possible to definitely fix the period. The infectivety of the condition was very strongly suggested by certain cases. Actual trench conditions were experienced for the first time by our H. Q. Company during July. At the beginning of August the first case of shin-pain illness occurred in this company. There were five subsequent ones chiefly in the signal section. Through the whole period cases of general muscular pain associated often with cough and headache occurred with varying frequency; as a rule when the shin-pain cases are most frequent so are the others. A few general muscular pain cases developed pains in their shins and had relapses.

Fourth.—After the end of October the shin-pain cases almost disappeared. In October the morbidity from such cases was 90 per 1,000; in November it was 10 per 1,000.

The general muscular cases often with coughs increased during November by more than 100 per cent. In October there were thirty-two such cases in the unit and in November there were sixty-nine. The records for December show an exactly similar state of things, namely, the practical disappearance of shin-pain cases and a steady flow of cases with general pains and more or less marked naso-pharyngeal symptoms.

That cases of pyrexia, often recurrent, associated with pains generally confined to the tibiæ and worse at night, do occur amongst the troops of the Western Front is I think established. There has been some literature on the subject of varying value. The tendency has been to group all pyrexias together, when the cause of the pyrexia was not obvious, and to call them "trench fever." There is no doubt that many real naso-pharyngeal infections with organisms of the catarrhal group have quite undeservedly gained this imposing title. I am certain that the majority of my cases with general muscular pains and slight coughs were really such infections. As everyone knows, a Friedländer infection or a *B. influenzæ* infection can cause much general discomfort with few local signs. These cases have been in my experience exactly what is called an influenza cold or "a chill" in general practice.

The shin-pain cases are quite different both in symptoms and course. This seems fairly generally accepted.

There has been a good deal of literature regarding these cases. In the *British Medical Journal* for February 12, 1916, Captain J. W.

McNee describes such pyrexias as seen in a C.C.S. In the same journal for November 11, 1916, Captain Muir gives the field ambulance point of view. In the number of November 25 there is the gist of a meeting of the Hamburg Medical Society, giving extracts from the chief German and Austrian medical papers dealing with the same subject.

Everyone seems pretty well agreed as to the salient characteristics of the disease, namely, pyrexia coming on suddenly with pains in the bones, especially the tibia, which pains are sometimes very severe. The tendency of the pyrexia to recur after several days of normal temperature and freedom from pain is also mentioned by all the writers. The Germans say that in every case the X-rays have confirmed the diagnosis of periostitis. On the other hand I have the word of a British Medical Officer who has recently joined this Division from a base hospital and he assures me that skilled radiologists have examined many cases and found absolutely nothing abnormal. All I can say is that very often the tenderness seemed to be a short distance to the outer side of the tibia.

Then again there has been a discusssion as to whether these cases might be a form of infective neuritis chiefly affecting the legs. This is possible but in no case have I detected any tenderness along the nerve trunks, and muscular wasting does not occur. It is also hard to imagine a neuritis that could disappear in a day and return with increased severity within a week. Certainly the increase of pain at night and its relief by heat are what one does find in cases of definite neuritis.

Yet another theory regards these cases as malarial. Acute pains in the legs are a not uncommon accompaniment of some malarial infections. The absence of the disease, as far as my experience goes, during cold weather, would also support this theory to some extent.

General —— was desirous of trying the effect of quinine on these cases and I put a platoon on six grains a day. Unfortunately the disease was decreasing at the time and there have been very few cases in the battalion since it was started. It has not therefore had a fair trial, but it is undoubtedly worth trying and I intend to make some further observations on its effect.

The puttee theory is another attempted explanation of the condition. It asserts that the constant pressure of puttees, especially if wet, so acts on the nutrition of the lower leg as to cause a type of chronic infection. The whole symptoms of the disease, however, are those of a general infection and not a local inflammation. This theory would also fail to explain the recurrence of pyrexia and shin-pains in men lying in bed with no puttees on.

An organism which would cause the condition is equally unknown. There are some, I think a decreasing number, who regard all cases of pyrexia of doubtful origin as due to an enteric group organism. The occurrence of these shin-pain cases chiefly during the spring and summer months would at any rate lend some support to the theory that the infection is insect borne. There is however no evidence to suggest that

the infection is of the enteric group. In the first place the bacteriologists of the Army have worked unremittingly to find such an organism in these cases without success. I think that everyone will agree that such testimony practically excludes the possibility of this type of infection being the cause of these cases.

My own experience goes to show that full inoculation with T.A.B. is no protection at all against this condition. As I said before, half the battalion was inoculated fully with $\frac{\text{T.A.B.}}{2}$ at the end of April. In the shin-pain recurrent cases of July, August and September, which were thirty-one, sixteen were so inoculated.

This impartiality of the shin-pain organism in attacking those inoculated and those uninoculated with $\frac{\text{T.A.B.}}{2}$ seems to me to put the theory of its being a paratyphoid A or B organism quite out of court.

Another point against this theory is the fact that men can get second attacks of this illness. No typhoid or paratyphoid organism behaves in this way.

Another theory is that this illness is a disease of exhaustion or of wet trenches. As a matter of fact, when our men were in the wettest place and had the hardest work, namely, last winter in X—, there was none of this kind of infection at all.

Rats and lice have been said to carry it. The X— trenches were full of rats and a year ago last month (November, 1915) 300 men in the battalion were definitely lousy.

This paper is really meant to be suggestive only. I state the facts as I have seen them but am very unwilling to draw any very definite conclusions.

All one can say is that here is an illness with certain definite and unusual symptoms. It appears to be infectious but not very greatly so. The evidence seems to me to put typhoid and paratyphoid infections out of court. It seems to prefer the summer for its appearance. It is to be observed in Captain Muir's paper that his cases increased in spring and summer. He blamed the cold, and excessive exhaustion. The Germans write about this illness in June and July and describe it also as occurring in autumn. The occurrence in summer makes one suspect that it may be a fly-borne disease.

The fact that at X— we did not have a case of this illness and that as soon as we moved to Z— it commenced, makes one think that possibly the disease may be endemic. Another thing that is common at the one place and not at the other is the number of unburied bodies. The question arises whether that might have anything to do with the disease.

Altogether there are many very interesting questions still to be answered, and I think you will agree with me that their ultimate decision lies with one man, namely, the bacteriologist.

CLINICAL OBSERVATIONS ON ONE HUNDRED CASES OF "TRENCH" NEPHRITIS.[1]

By Captain S. C. DYKE.

Royal Army Medical Corps.

The 100 cases from which this report is compiled were all seen at a General Hospital in France, in wards especially set aside for the reception of nephritic patients. The actual period of observation extended from early in January until late in February, 1917; the dates of onset in the cases considered varying from late in November to late in February. During the first few weeks of this period—that is, throughout the latter part of November and the whole of December, 1916—the weather was such as is usual in Northern France at the season—moderately cold, damp and sunless. From then onwards was a period of intense cold with northerly winds, snow, and a high proportion of bright clear days. The majority of the patients taken ill during the earlier period had suffered from exposure to cold and wet; during the latter the degree of cold was greatly increased, but the element of damp was largely eliminated by the continuous frost. With the exception of two cases, in which the kidney symptoms were discovered after admission to hospital, they all came down from the Casualty Clearing Stations with diagnoses of nephritis, acute nephritis or albuminuria. They varied greatly in severity from cases showing very marked signs of kidney trouble of a serious nature down to patients in whom the only symptom was the presence of albumin in the urine.

The cases at the two ends of the scale of gravity shaded so imperceptibly into each other that it was found impossible to make any line of demarcation, having on the one side those showing a morbid and on the other those with a possibly abnormal, but not necessarily pathological, condition of the kidney. No sharp line could be established between what were obviously that condition which one is accustomed to call acute nephritis, on the one hand, and on the other the cases which one might have been tempted to describe as "functional" or "postural" albuminuria. All seemed to be indications of an affection of the kidney differing in degree only.

The series included cases from many formations. The percentages were: Infantry 80; R.E.'s 8; R.F.A. 5; A.S.C. 4; R.G.A. 1; R.A.M.C. 1; R.F.C. 1. The formations in question were all actually in the field—that is to say none of them were stationed at bases or on the lines of communication, and consequently even when not actually "in the trenches" the men had been subjected to considerable exposure. The one patient from the R.F.C. was attached to a kite balloon section on the Somme and had been living in roughly made shelters.

[1] Received for publication May 25, 1917.

Age.—The incidence in regard to age is spread with a rather striking evenness over the five-yearly periods between 20 and 40. The vast majority of the British soldiers in France fall between these ages, and it is not surprising that only one case occurred below 20, the age of this patient being 19. Considering, however, how comparatively few men of 41 or over are on active service in France it is rather suggestive that eight per cent of the cases fall into this category. The ages of incidence for the remaining ninety-one cases were as follows:—

Age	20 to 25	23 cases.
,,	26 to 30	21 ,,
,,	31 to 35	23 ,,
,,	36 to 40	24 ,,

There are probably considerably more men in the British Expeditionary Force in France between the ages of 20 and 30 than between 31 and 40, and it is certainly worthy of note that the number of cases in the former group was only forty-four as compared to forty-seven between the latter ages. There are, moreover, certainly fewer men in the field between 36 and 40 than between 20 and 25, and the fact that the figures for these two series are almost identical, 24 as compared to 23, points to the same conclusion —namely, that the liability to the malady increases with age.

Service in the Field.—A consideration of the time of service with the British Expeditionary Force brings out no very striking fact, save that twenty-one per cent of the cases had been in France for over one year. Three patients had been in France for only one month, but no period under that was recorded. The service in France of the remainder was as follows:—

1 to 3	months	23 cases.
3 to 6	,, ...	28 ,,
6 to 12	,, ...	25 ,,

Past History.—Investigation into the past history of the cases revealed a comparatively high incidence of acute rheumatism, a history of this disease being obtained in eleven. That the disease actually was acute rheumatism was ascertained as nearly as possible by enquiry as to symptoms remembered by the patient and length of stay in bed. Next to acute rheumatism came scarlet fever with an incidence of ten, in two cases with a definite history of consequent kidney trouble. Including these two cases acute kidney trouble occurred five times in all; in four other cases there was a history of swelling of the face and feet in the past of unknown causation, but probably associated with renal disorder. Of the other exanthemata measles occurred twice and diphtheria twice.

Onset.—The onset in the great majority, eighty-five of the cases, was gradual. In the remaining fifteen the patient up to that time feeling comparatively well—as well as men expect to feel in the trenches in winter time—was taken ill so suddenly and violently as to be forced there and then to give up his work and go sick. Of these cases of sudden onset the first symptom in five was dyspnœa, in another five œdema coming on

suddenly during sleep. Two patients reported sudden and severe headache, in one case associated with vomiting; in one case præcordial pain was the immediate cause of reporting sick, while one patient admitted unconscious could remember nothing from the time of his disembarking from the leave boat.

Symptoms.—Œdema. Œdema described by the patients themselves as "swelling" was the most frequent symptom of all. In twenty-two this was the first thing noticed; in sixty-eight it came on later; in a few cases not being noticed until the patient was actually in the Field Ambulance or Casualty Clearing Station. In only ten of the cases could no history of œdema be obtained.

In four cases it was curiously localized. In one of these on arrival in hospital the patient showed, with a slight general anasarca, a great enlargement of the right leg with little of the left; in this case no sore or other cause could be found to account for this difference. In a second case in which there was swelling of the left leg but none of the right, a small ulcer was present in the popliteal space on the affected side. This appeared before the swelling and healed in advance of the disappearance of the œdema. In a third case an œdema confined to one side of the face was associated with septic teeth on that side of the jaw. In the fourth case the immediate cause of the patient's being evacuated from his unit was an intense œdema of the scalp and forehead. A note accompanied this patient from the C.C.S. to the effect that the swelling resembled a cellulitis, but that no septic focus could be found. All these four cases showed albumin, casts and blood in the urine. In the remaining cases the œdema was most frequently noticed by the patients in the face and backs of the hands. The thighs and knees were often reported as having been swollen—the legs less frequently so—this probably being due to the constriction of the puttees. In hospital the œdema was found to persist longest in the back and below the malleoli.

Other Symptoms.—The next commonest symptom was headache, which was complained of by fifty-nine. Of the more typical symptoms the most frequent was dyspnœa in forty-seven. Cough, often very severe, was present in thirty-six cases. Coryza was present in 16, hoarseness or loss of voice, presumably due to laryngitis, in 5, and sore throat in 5.

Early symptoms possibly referable to the urinary system were as follows: Pain in the loins in 39 cases; painful micturition in 7; frequent micturition 7; incontinence of urine 1. In three cases a diminution of the amount of urine passed was reported.

Vomiting was present at the onset in fifteen, and diarrhœa in four cases.

Apart from the pain in the loins referred to above, pain in other parts was also a prominent feature at the onset. A general aching, similar to that experienced in influenza, was described in 8 cases, in 16 it was localized in the legs, in 13 apparently in the muscles and in 3 in the shins. These last three cases were interesting as the pain and tenderness

was similar to that present in "trench fever," and like it was associated with pain in the back. Pyrexia was present in these three cases for some time after the onset. It seems possible that there was here an intercurrent infection of the type known as "trench fever." Epigastric pain was present in six and præcordial in three cases.

Epistaxis was reported in three cases. In five subconjunctival hæmorrhages were present. In two cases these were a very marked feature—in one the whole visible surface of the sclerotic was hæmorrhagic, while in the other the discoloration was sharply confined to the outer half of each eye.

Shivering (? rigor) was present at the onset in five cases.

Pyrexia.—The earliest that any of these cases were seen was on the third day from the onset, while many were not seen until the tenth day; consequently it was impossible to determine whether or not the onset was attended by pyrexia in all cases. That this was sometimes the case was shown by occasional notes on the field medical card, recording temperatures up to 103° F.

Eighteen of the 100 cases only showed any pyrexia on admission. In 6 the temperature dropped to and remained at normal within fourteen days of the onset, 5 more fell to normal within the third week, and 4 more within the fourth. The remaining three continued some degree of fever into the fifth week of the illness. It was very noticeable that the majority of these eighteen cases admitted with pyrexia showed some intercurrent affection sufficient to account for the fever. In 6 this was bronchitis, 3 more were the suspected cases of "trench fever" already mentioned, and 1 apparently a pyelitis.

A rather remarkable feature of the temperature chart was the occurrence, quite unexpectedly, and for no apparent cause of short periods of pyrexia, of from twenty-four to seventy-two hours. These were unattended by symptoms, except sometimes by headache and pain in the back. In 10 of 16 cases these occurred in the second week of the disease; in 4 in the third, and in 1 in the fourth. In one case three such minor relapses occurred in the fourth, fifth, and sixth weeks respectively.

Longer periods of pyrexia of from four to ten days after an apyrexial period occurred in seven cases, but in all these, with the possible exception of one, the causation of the fever was easily explicable. In 3 it was accompanied by severe bronchitis; in 1 by intestinal disturbances and diarrhœa; in 1 by a carbuncle on the face; and in another by marked shin pains and an apparent recurrent attack of "trench fever." The seventh case was a severe relapse, with drowsiness and marked hæmaturia, to which reference will be made later.

The conclusions arrived at in regard to pyrexia were:—

(1) That apart from the actual time of onset on which records were not obtainable, pyrexia is not usually present in the early stages, unless due to some intercurrent infection.

(2) That short pyrexial periods are liable to occur without apparent cause at any time up to the fourth week.

(3) That longer pyrexial periods occurring after an apyrexial period are always due to an intercurrent infection.

Association with Bronchitis.—The association of bronchitis with the kidney symptoms has been mentioned several times above, and, indeed, this was one of the most striking features of the series. It was actually seen, or a history of it obtained, in thirty-six cases; and it is probable that it was an early symptom in a great many more, as men in the trenches in winter get into the habit of disregarding a cough unless of unusual severity.

In four cases the bronchitis was so severe as to endanger the life of the patient, being of the purulent type, which has been so fatal in the British Expeditionary Force in France. In one of these cases pure cultures of *Bacillus catarrhalis* were obtained from the sputum; in a second of *B. influenzæ*. The remaining two were mixed infections, with a prevalence of the pneumococcus. These bronchitic cases were always troubled by dyspnœa, and this and the "weakness," complained of by twenty of the patients, probably accounts for the large incidence of dyspnœa found in the history of the onset.

Besides signs of bronchitis in the lungs, it was no uncommon thing in the œdematous cases to obtain signs of fluid in the pleural sac at both bases. Its presence was demonstrated by exploration in three cases. The fluid was of a clear straw colour, and free from cells of inflammatory origin.

The Heart.—The apex beat was found in the sixth intercostal space in sixteen of the cases, but in only four was there any marked enlargement. In three cases a fugitive systolic bruit, apparently not due to any organic lesion, was heard at the apex.

The Urine.—Amount: Oliguria, understood as an output of urine of less than thirty fluid ounces in the twenty-four hours, was present for anything up to three days after admission in about 15 per cent of the cases, but was apparently due more to previous diminished intake of fluid than to any lack of functional capacity on the part of the kidney. In no case was there any difficulty in establishing a good flow of urine so soon as the patient was placed on suitable diet and drinks. In two cases patients went from twelve to eighteen hours without passing water, but the urinary flow was soon re-established under hot poultices to the loins and diuretic drinks.

In those cases with a low urinary output the specific gravity was high; thus, on the first two or three days after admission a specific gravity of 1,025 to 1,038 was not uncommon. Later, with a free fluid intake, it was always observed to fall, remaining in the great majority of cases at from 1,010 to 1,012.

Very high daily outputs of urine were fairly frequent, being particularly noticeable at the commencement of the disappearance of a profound general œdema. The highest amount recorded was 193 fluid ounces in twenty-four hours.

The reaction was universally acid.

Albumin.—Albumin was present in the urine in every case except one not seen until the thirty-second day but previously diagnosed as nephritis. It disappeared while the case was under observation in twelve cases, this disappearance taking place on dates from the eighth to the thirty-fifth day of the disease. The remaining cases all went to England still showing albumin in the urine, although in every case the percentage was sensibly diminished below that with which they were admitted. In only nineteen cases were the patients evacuated with an Esbach reading of more than one gramme of albumin to the litre of urine. As the cases were first seen at all periods in the course of the disease, very varying degrees of albuminuria were met with on their admission. In some instances, notably where there was much œdema and bronchitis, the Esbach reading was extremely high. In many cases it was far above the 12 mark on the Esbach tube, in one instance the reading remained above this mark for four days after admission, even after fourfold dilution, indicating the presence of well over forty-eight grammes of albumin to the litre. There was further a tendency for sudden increases in the intensity of the albuminuria after periods of comparatively low albumin content. Such rises in the albumin output were often associated with periods of pyrexia (figs. 4, 5 and 6); in favourable uncomplicated cases the diminution in albuminuria was rapid (figs. 2 and 3.)

Casts.—Casts were found in almost every case, though often not until repeated search had been made. They were usually granular or epithelial. Hyaline casts were also fairly common. Blood casts were found twice and waxy once. The only importance attaching to the presence of casts seems to be that in very large numbers they indicate a severe degree of damage to the kidneys. In a few cases the urine on standing formed a sediment consisting almost entirely of granular casts, and these were particularly severe and obstinate cases.

Hæmaturia.—Hæmaturia was present in every case; it varied greatly in degree, however, from cases where microscopic search of centrifuged urine yielded only a few red blood cells, to those in which the presence of blood in the urine was obvious to the naked eye. Urines showing much blood macroscopically fell into two classes—those in which the specimen was of a bright cherry red, without much sediment, and those of a dark brown colour with tendency to formation of a thick brown sediment on standing. This latter type of urine was always associated with what Abercrombie has described as "lower tract" cases, that is, those showing symptoms referable to the bladder and ureters. This is not a common type of the disease, only five cases occurring in the series, but it is very striking when seen. The patient complains of severe pain in the loins—sometimes confined to one side only, of frequency of micturition, and of scalding pains during and more particularly at the end of the act. Rather more headache than was usual in the ordinary type of case was complained of in these

cases; and fairly severe vomiting was present once. The urine in addition to large quantities of blood cells always showed bladder epithelial cells, sometimes in large amount. The big cubical cells from the superficial layer of the bladder epithelium were the most commonly seen, but stalked cells from the deeper layers of the epithelium were not infrequent. The cells usually occurred singly or in clumps of two or three, but occasionally sheets of epithelium, large enough almost to cover the field of a one-sixth objective, were met with. In addition to blood and epithelial cells from the bladder, these urines also always showed considerable numbers of granular casts. The appearances seemed to point to a certain degree of infection of the bladder epithelium, but a cystoscopic examination was not made. It is to be regretted that the series had to be closed before thorough bacteriological and cytological examinations of the urines in these cases could be made, because they seem to provide a peculiarly promising field for the identification of any infecting organism or other cause of this malady.

A peculiar feature of the centrifuged urinary sediment was the almost constant presence of polymorphonuclear leucocytes. In those where the hæmaturia was intense it was naturally impossible to make out whether or no they formed an unusually large proportion of the blood cells present. Where, however, fewer red cells were present the high proportion of polymorphonuclears was often very noticeable, and it was a common thing to see specimens under the microscope in which the field of the one-sixth objective showed everywhere from six to a dozen of these cells with only an occasional erythrocyte. In only one case was pus actually present to the naked eye, and this was the case of pyelitis already referred to. The microscopic picture was here quite different, the whole field being thickly crammed with leucocytes; large leucocyte casts were also present.

Salt Content.—Estimations of the salt content of the urine by Volhard's method were made in six cases, and in every one it was found that this was low while the œdema lasted. With the disappearance of the œdema the salt content of the urine rose (fig. 7). During these estimations the patients were kept on a constant diet, low in, but not actually free from, sodium chloride. The exact amount ingested daily was not known but it was fairly constant. It had been intended to conduct some experiments on the power of excreting sodium chloride during the persistence of the œdema, but unfortunately observations had to be closed before this was done. Extra sodium chloride was fed to one case during the disappearance of the œdema and was found to be well excreted (Case 54, fig. 7).

The Blood.—Urea content: Determination of the urea in the serum or whole blood was carried out in nineteen cases. Either whole blood or serum was used as convenient, it having been found that the difference between the urea content of the two from the same case was so small as to be negligible. When whole blood was used it was laked by the addition of distilled water. The laked blood or serum was then treated with

metaphosphoric or trichloracetic acid to eliminate the proteins, and the filtrate then treated with sodium hypobromite. The amount of nitrogen liberated was measured, the result reduced to standard temperature and pressure and then expressed in terms of urea. The method is not absolutely accurate but nearly enough so for clinical purposes.

The highest reading obtained was 1·34 grammes per litre on the fourth day from the onset, the lowest 0·46 on the twelfth day. The case giving the reading of 1·34 was one showing marked œdema and intense bronchitis without any "uræmic "symptoms, except a high-tension pulse. Readings of 1·19 on the fifth day, and of 1·25 on the seventh were obtained in two other cases similar, except that bronchitis was not present to the same degree. In a fourth case admitted unconscious, but without œdema or any other symptoms of renal trouble apart from a moderate albuminuria, a reading of 1·20 was obtained on the fifth day.

That the urea content of the blood falls rapidly with improvement was shown in this last case. On the seventh day, with considerable decrease of the mental symptoms the reading was 0·97 gramme per litre, while on the fifteenth day, when the condition except for a slight headache and a trace of albuminuria was normal, it had fallen to 0·56. In the case in which the reading was 1·25 on the seventh day it had fallen by the twelfth to 0·79.

Two cases of great severity gave readings of 0·79 and 0·66 gramme urea per litre of blood as late as the forty-seventh and fiftieth days of the disease respectively. The former was not free from œdema even at that time and the latter had only been free for a short time. Both had shown intense œdema, much hæmaturia, and were still passing casts in large quantities. The former case still showed six grammes and the latter four grammes of albumin to the litre of urine. Another similar case showed 0·77 gramme urea to the litre of blood on the twenty-sixth day. These were all cases in which the symptoms pointed to a very high degree of damage to the kidney, and the high urea readings of the blood at comparatively late dates in the course of the disease merely served to confirm the general bad prognosis.

Other readings obtained were :—

0·76	gramme urea to the litre blood	on the 12th day.
0·75	,, ,, ,, ,, ,, ,,	4th ,,
0·62	,, ,, ,, ,, ,, ,,	2nd ,,
0·61	,, ,, ,, ,, ,, ,,	13th ,,
0·61	,, ,, ,, ,, ,, ,,	13th ,,
0·61	,, ,, ,, ,, ,, ,,	4th ,,
0·60	,, ,, ,, ,, ,, ,,	31st ,,
0·58	,, ,, ,, ,, ,, ,,	7th ,,
0·57	,, ,, ,, ,, ,, ,,	10th ,,
0·53	,, ,, ,, ,, ,, ,,	10th ,,
0·50	,, ,, ,, ,, ,, ,,	8th ,,
0·46	,, ,, ,, ,, ,, ,,	12th ,,

Acidity.—With a view to ascertaining if the dyspnœa present in so many cases was attributable to an increased acidity of the blood, determinations of the degree of acidity were made in eight cases by Captain Wolf, R.A.M.C. These cases all showed a certain degree of dyspnœa associated in every case with some bronchitis. In only one was any increase in the hydrogen ion concentration found. This was the most markedly dyspnœic of all the cases and bronchitis of some severity was present. The acidity reported here was p. H. ·83, corresponding to thirty-five millimetres of alveolar CO_2. In all the other cases the reading was p. H. ·85.

Uræmia.—Actual "uræmic" symptoms were only seen in one case in the series. This patient was admitted unconscious from another hospital; he was apparently taken ill with great suddenness, for no history could be obtained from him, except that the last thing he remembered was disembarking from the leave boat, at which time he felt quite well. No œdema was to be seen in this case, albumin was present to the extent of only ·05 per cent in the urine; no convulsions were observed. The patient slowly regained consciousness. Within a week of the onset he was perfectly rational and complained of nothing more than a slight headache. The findings of the amount of urea in the blood in this case have already been given.

The occurrence of "convulsions" was noted on the field medical cards of four of the cases. These patients were all admitted with œdema and albuminuria of varying degrees. Three of them cleared up with rather more than usual rapidity; the fourth was more resistent, but was ultimately evacuated free from œdema and with only ·03 per cent of albumin in the urine. It is inferred that the occurrence of convulsive fits early in the disease is not an event of grave prognostic import.

As compared with the experience of others who have had charge of nephritic patients in this War, the incidence of "uræmic" symptoms in this series seems to have been unusually low. This was probably principally due to chance, but it may also have been partly due to the fact that a careful watch was kept for such symptoms of approaching uræmia as intense headache, drowsiness, increased blood-pressure, and diminution of urine. On the appearance of such symptoms recourse was at once had to blood-letting to the extent of from fifteen to twenty-five fluid ounces.

Treatment.—Treatment centred mainly around the provision of a favourable environment and suitable diet for the patients. Throughout the period of observation all patients were kept in bed between blankets, but they were permitted to sit up in bed when they felt so inclined. While the acute symptoms lasted it was found that there was no tendency to do anything but lie quietly—and this even though on inquiry no complaint of pain or discomfort was made. An inclination to sit up and read or talk with other patients was usually the sign of the approach of convalescence.

In no case did untoward symptoms result from this general freedom, and that this was so was probably due to the fact that the wards were kept as nearly as possible at a uniform temperature of about 62° F., and free from draughts. The importance of the provision of a warm equable temperature for these patients cannot be too strongly insisted upon. It is more than probable that the relapses and sudden "uræmic" attacks which have been described as occurring with nephritis cases treated in general wards are solely due to chills acquired as a result of insufficient or irregular heating. The almost complete absence of such accidents in the present series was undoubtedly largely due to the success of the nursing staff in keeping the wards day and night at an almost constant temperature.

Three main diets were used in the wards—No. 1 consisting of cow's milk when procurable, or in lieu of it Glaxo or evaporated milk. No. 2, the same as No. 1, with the addition of one and a half slices of bread and butter and rice milk, and No. 3, comprising all of the above with the addition of milk puddings, custards and vegetables, excepting peas, beans, and lentils. Cases on No. 2 and No. 3 diets were allowed weak tea, coffee, and cocoa, and were encouraged to take as much sugar and butter as they wished. It was not found practicable to exclude the salt used in cooking the food, but no additional salt was allowed.

All cases on admission were placed on No. 1 diet; in the absence of much œdema or other severe symptoms they were soon put on to No. 2. In any event no case was kept on No. 1 diet for longer than ten days together. With the disappearance of the œdema and the reduction of albuminuria to below ·25 per cent they were moved on to No. 3 diet.

It has been suggested that the fluid, or solid nature of the diet, is of more importance than its chemical constitution. With a view to deciding this point, a series of similar cases were kept on Nos. 1 and 2 diets, but no difference in their course was noticed. Similarly, a series of six cases, all running from 1·0 to 0·08 per cent of albumin in the urine, were placed half on No. 3 diet only, and half on a daily portion of chicken in addition. At the end of a week, of the three cases on the chicken, one suffered from a severe relapse, with temperature running up to 103° C., hæmaturia and uræmic symptoms—the only relapse seen in the series; the second showed a rise of the albumin to 0·12 per cent, while the third suffered from drowsiness and headache, passing off on a return to the simple No. 3 diet. This was taken as an indication for care in raising the protein content of the diet too early.

Barley water and imperial drink were freely given to all cases except those with persistent œdema. Patients were not made to drink any set amount, but were encouraged to drink as often as they felt inclined to do so. Where the œdema persisted beyond the third week, the patients were not allowed to drink between meals, and were encouraged to take as little fluid as they could manage without inconvenience with meals. Under this regime the œdema in ten out of twelve obstinate cases disappeared.

Packs.—Hot packs were given as a daily routine to all cases with œdema. The packs were given with hot-water bottles, six to a case, and seldom failed to produce an intense diaphoresis. In those cases where the reaction was not good, pilocarpine $\frac{1}{10}$ to $\frac{1}{5}$ grain was given subcutaneously, but it was seldom necessary to have recourse to this measure. Pilocarpine was never given to bronchitic or dyspnœic cases, and no evil results were seen following its use.

Venesection.—The experience gained in this series seems to show that by far the most useful therapeutic measure was free blood-letting. This was practised to the extent of from ten to twenty-five fluid ounces, and was found most efficacious in relieving headache and dyspnœa. Its use in connection with threatened uræmia has been referred to above. The median basilic vein was usually chosen, and the blood withdrawn either through an open incision or by means of a cannula.

Drugs.—Of drugs citrates, acetates and carbonates were exhibited in various combinations. For the "lower tract" cases a mixture containing sodium bicarbonate, urotropine, and tincture of hyoscyamus, was found very useful. This never failed to relieve the most troublesome symptoms, such as pain in the loins and scalding micturition, but had no effect on the hæmaturia accompanying these cases. Tr. ferri perchlor., in combination with liq. ammon. acetat., was given to combat the anæmia which often appeared late in the course of the disease.

Bronchitic Cases.—The only cases presenting any difficulties in management were those complicated by severe bronchitis. Before the subsidence of the bronchitis, these patients were often reduced to an extreme degree of debility.

A diet of a more stimulating nature than that permitted to the uncomplicated cases was allowed to these patients. A raw egg beaten up in a pint of milk was given daily; small portions of chicken were allowed on every second or third day, and the patients were plied with oatmeal gruel and arrowroot. In spite of the raised protein content of this diet, no harm was seen to result from it. Whisky or brandy, to the extent of two fluid ounces daily, was also occasionally administered without harmful results. These cases took all the ordinary expectorant and stimulant drugs well. Digitalis to the extent of one fluid dram of the tincture daily was given over considerable periods, and with none but beneficial results.

Mortality.—No deaths occurred in the series during the period of observation.

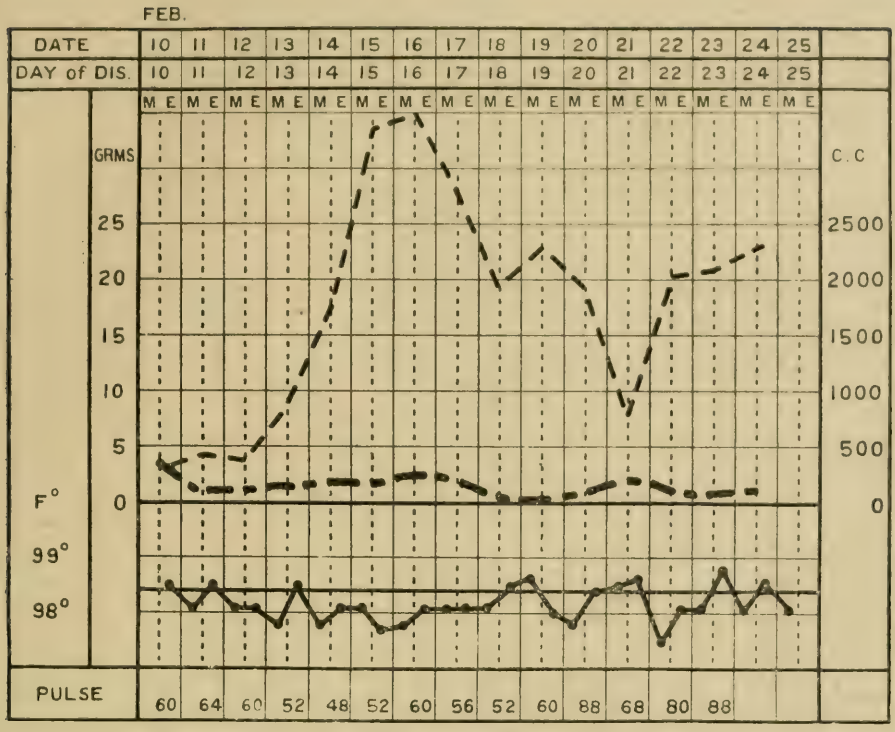


Fig. 1.—Apyrexial case.

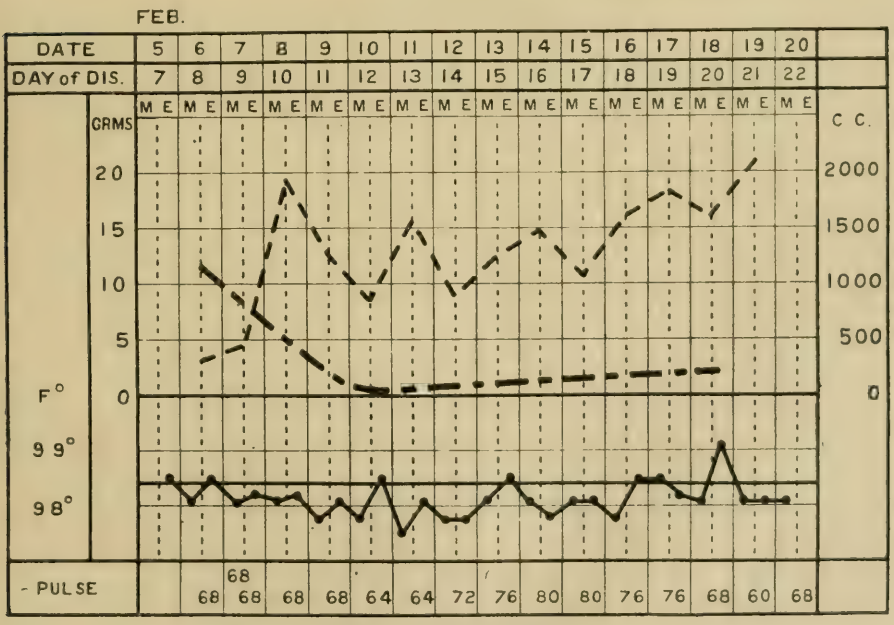


Fig. 2.—Apyrexial case.

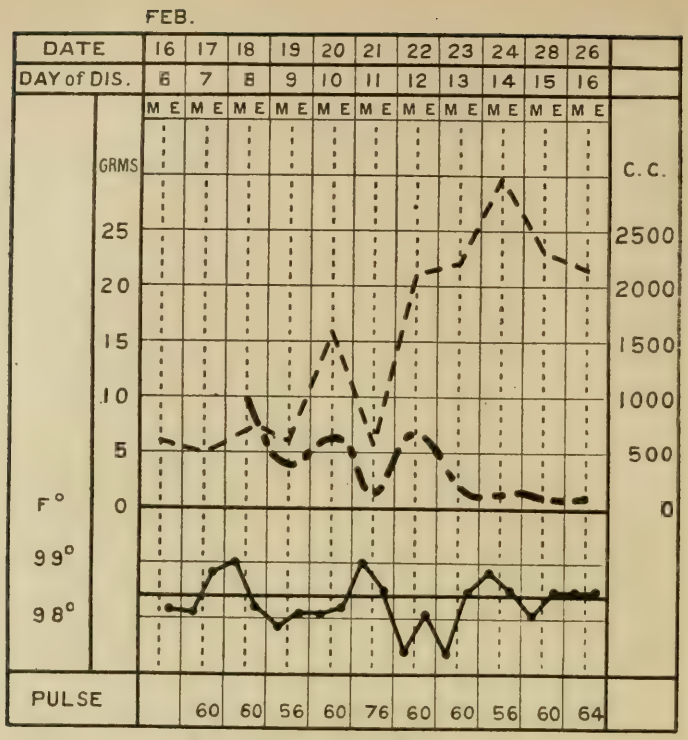


Fig. 3.—Case with slight pyrexia.

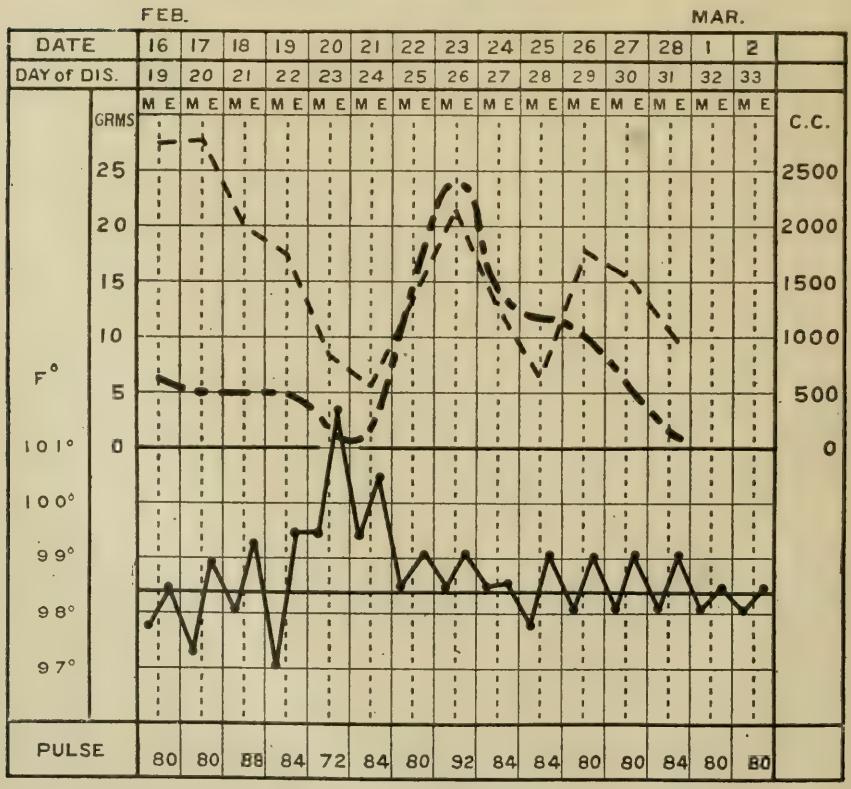


Fig. 4.—Pyrexia of short duration and of unknown causation.

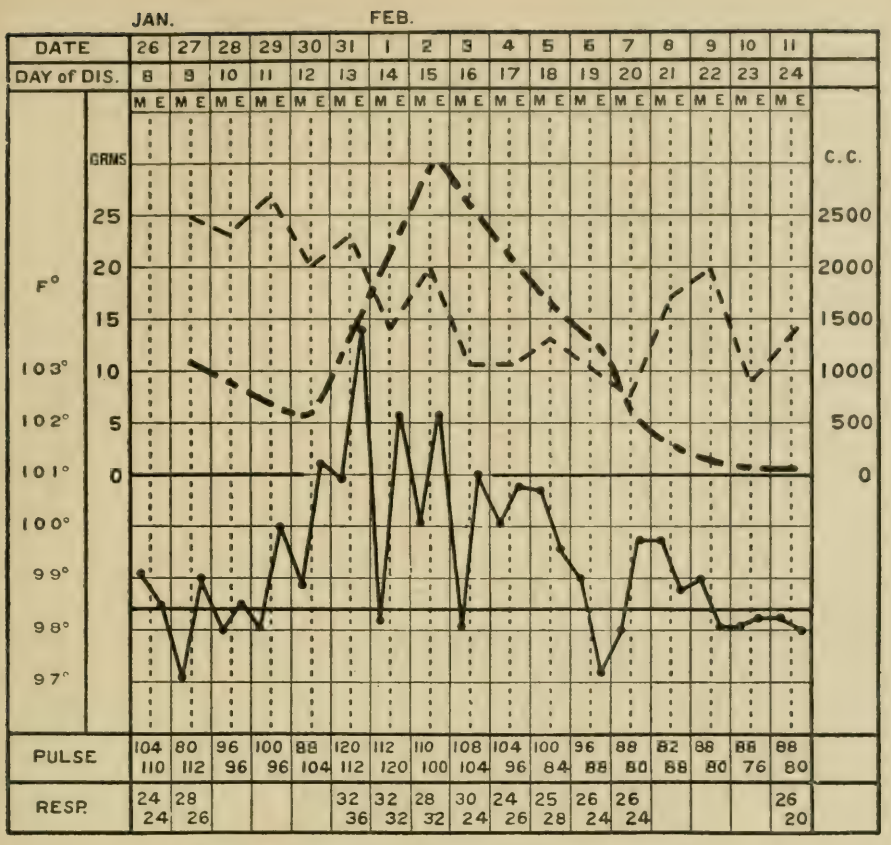


FIG. 5.—Pyrexia due to severe purulent bronchitis.

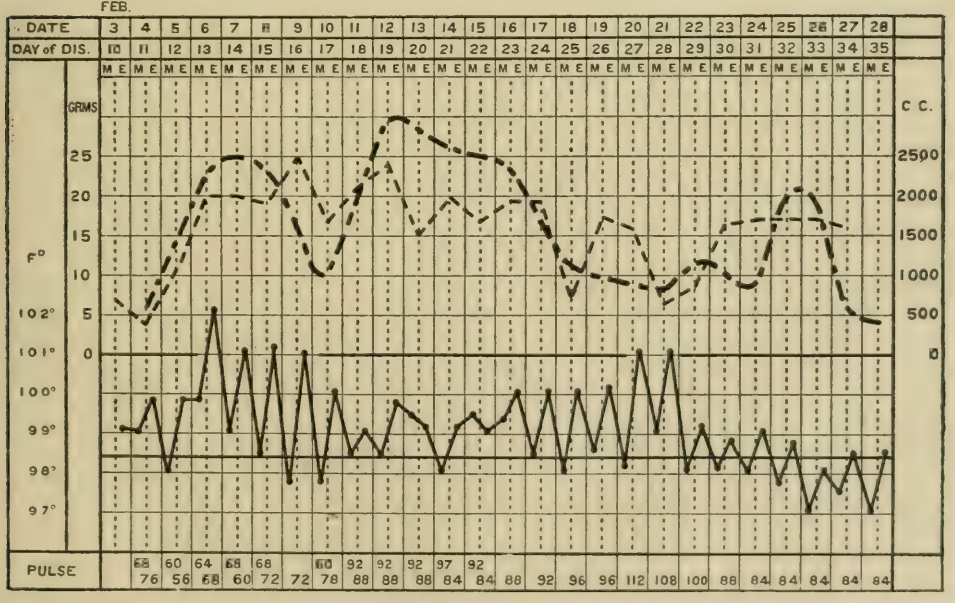
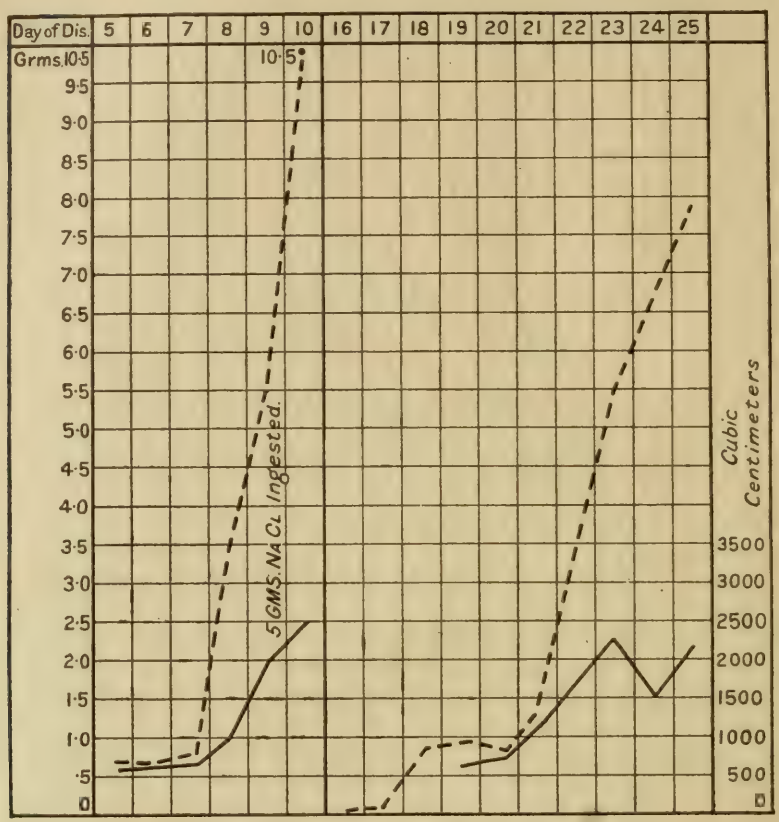


FIG. 6.—Continued pyrexia without bronchitis.



Case 54 Case L. A.

FIG. 7.

FIGS. 1 TO 6.

Charts showing daily temperature, degree of albuminuria, and excretion of urine.

Thick broken line represents amount of albumin excreted daily, expressed in grammes. It is constructed from Esbach tube readings, and is to be regarded as only approximate. To be read by the scale to left of the sheet.

Thin unbroken line represents daily excretion of urine in cubic centimetres; to be read by scale to right of the sheet.

FIG. 7.

Excretion of sodium chloride.

Broken line represents daily excretion of sodium-chloride expressed in grammes; to be read by scale to left of sheet.

Unbroken line represents daily excretion of urine expressed in cubic centimetres; to be read by scale to right of sheet.

Clinical and other Notes.

THE AFTER-HISTORY OF WAR NEPHRITIS: WAR NEPHRITICS INVALIDED TO ENGLAND.

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There have been published a number of excellent papers upon war or trench nephritis as it occurs in France, but the question of what eventually becomes of the patients has not been clearly worked out. The condition is usually regarded as a comparatively mild form of acute nephritis, and it is probably true that the majority of cases occurring in France and Flanders recover sufficiently in rest camps or field ambulances to permit of their return to the line. A minority of cases, those in which there is pronounced dyspnœa or extensive œdema, find their way into base hospitals in France, and here they are treated until these symptoms have abated or disappeared, and then are returned to England for further treatment. Of these a few are already free from albumin, casts, and blood, but by far the greater number still afford traces of these pathological elements in the urine.

The present investigation was commenced by Captains J. D. Bruce and A. R. Robertson in the latter part of November, 1916, when a special ward for nephritis was opened. Captain Bruce, unfortunately, left shortly afterwards, and the work was then carried on by the writers, with the purpose of ascertaining the after history of these cases.

To Captain Bruce, and also to Colonel Rudolf, our thanks are due for many helpful suggestions.

While it is true that the mortality in acute stages is practically nil (any death that has occurred among such seeming almost always to have been due, not to a primary condition, but to exacerbations of an old nephritis), it is evident from observations here recorded that the great majority of patients, ill enough to be sent to England, are still far from well at the end of three months. It is now necessary, we would suggest, that a further study be made of the condition of this class of patients at the end of, say, six months and of a year.

We have been able to investigate a considerable number of these cases, and for the purpose of this communication have subjected fifty to a detailed study—after a lapse of from two to three months or more from the onset. We have tried, by

careful questioning as to the exact mode of onset and subsequent course in France, to ascertain what manner of case it is that fails to clear up quickly, and tends to lapse into a subacute or chronic condition; this has revealed some interesting facts.

In our 50 cases we find that the average period of service in France was five and a half months, that 43 had done duty in the front line—either in trenches or gun positions—and that 7 were never at any time in the front line,[1] but were on duty either at a base or only as far as a railhead. As to past illnesses, 9 had had scarlatina in childhood, followed in one instance by severe nephritis; 13 had had measles, with no serious sequelæ; 5 had had pneumonia and 5 rheumatic fever. In three cases there was a clear history of syphilis, which in two patients seems to have had some bearing upon their present condition.

All claimed to have been in perfect health upon arrival in France. All ate the same food, and, with the exception of three, who admitted having drunk trench water when other was not obtainable, stated that they had used only the water that was served out. It is, however, entirely probable that most soldiers at some time use trench or shell-hole water.

The most frequent initial symptom was acute catarrh of some part of the respiratory tract—trachæo-bronchitis in 27, coryza in 23, and "sore throat" in 17. Rarely the entire tract was involved. Accompanying this, but usually following a short time after, was weakness and malaise in forty-four, and chills in twenty-five cases. Some degree of fever was probably present in all cases, but from the patient's own statement a history was obtainable only in twelve. Following this came dyspnœa in forty-seven cases—in forty of which it occurred in bed. Dyspnœa was also a fairly frequent first symptom. Then came œdema of varying degree in forty-nine cases, occasionally only as a slight swelling under the eyes, or of the feet. In order of onset, œdema first occurred in the face and under the eyes, then in feet and hands. Accompanying, or often preceding the œdema, was headache of varying intensity in 37 cases—of post-ocular or supra-orbital character in 25, and occipital in 3. In twenty-nine the headache was dull and constant; in nine it was sharp and lancinating. The commonest pain elsewhere was across the small of the back in 40 cases; in the muscles of the legs in 32; abdominal pains were not infrequent, usually epigastric, and of a cramping character in 16; in 13 there were joint pains, and in 19 pains in the long bones. Nausea and vomiting were present in twenty-six cases. Vertigo in thirty-one cases was also quite frequently an initial symptom. Other symptoms that frequently followed were: loss of weight in 25; insomnia in 37; anorexia in 15; diarrhœa in 9; constipation in 11; profuse sweats in 18; dryness of skin in 12; mental torpidity in 10; convulsions in 3, and partial or complete unconsciousness in 5. Visual disturbances occurred in eighteen, in one of which there was complete blindness, except for perception of light, over a period of about two weeks. Blurring of vision was the commonest occurrence, and usually came on with the onset of œdema of the orbital tissues. Objects could be seen, but their outline would be indistinct—as would be the case in errors of refraction. In one case the patient volunteered the information that, whereas in good health he had always had to use glasses for reading, he was able to read quite easily during the time that orbital œdema was marked. It seems possible that a change either in intra- or extra-ocular pressure,

[1] Hence our preference for the term, "War Nephritis," rather than "Trench Nephritis."

due to œdema of the eye or the orbital tissues temporarily altered the refraction of the eye.

The ocular changes that may have been present during the acute phase of our cases were probably those that have been commonly noted in France—œdema of the retina and the disk, phenomena which were occasionally noted in those that entered with œdema, or those in which œdema subsequently reappeared.

The commonest complaint upon entering this hospital was dull frontal headache, usually present upon awakening in the morning, and passing off towards midday. Accompanying this were pains across the loins, deep-seated, dull, sometimes unilateral, but usually bilateral, and occasionally radiating downwards towards the pelvis. It was not observed that the degree of pain bore any relationship to small fluctuations in the amount of albumin and blood (usually small) present in the urine. Dyspnœa, on exertion, has been a constant subjective symptom in all cases, with one exception. That this is often real is amply borne out by the fact that some of the patients doing light duties in the ward become dyspnœic very quickly. In a few cases a transient dyspnœa would cause the patient to "start" with a smothering sensation out of a deep sleep; such nocturnal attacks have, though, been both rare and transient. However, the fact remains that the dyspnœa is, even after two or three months from the onset of the malady, such a constant subjective symptom that we have been endeavouring to ascertain to what extent this subjective symptom is confirmed by means of physical exercise tests. We have selected only those cases in which "shortness of breath" on exertion was a voluntary statement on the part of the patient, in no wise elicited by questioning. The patient was told that the physical exercise tests were of the nature of "pulse tests." Sufficient observations have not as yet been made from which to draw definite conclusions, yet we feel fairly sure that much of the dyspnœa in patients who have been free of œdema and high blood-pressure for some weeks, with urine almost or entirely free of albumin and blood, is psychic or functional in character. It is well known that after recovery from nerve paralysis, following an injury, there is often a greater or lesser amount of functional disability due to the patient's own impression that he cannot now use the muscles supplied by that nerve.

In a precisely analogous way it is possible that in many of these nephritics the early pathological dyspnœa is succeeded by a purely functional dyspnœa. Our observations upon this subject will be given in a further communication.

In all cases that we have examined after a lapse of three months we have found no enlargement of the heart—even in those few cases in which there is still some increase of blood-pressure and second aortic accentuation. In twenty-five cases seen after a lapse of three months there were four which showed a constant increase of systolic blood-pressure—from 160 to 190—with accentuation of the second aortic sound. In two of these the œdema had been severe and prolonged with subsequent slight exacerbations on several occasions, the amount of albumin had been large, and there was much anæmia. A third case in a man over 40 was more the picture of chronic interstitial nephritis that probably antedated the War. The fourth was the only case in which there was severe albuminuric retinitis. His history is as follows:—

No. 7211, Pte. R. S. M., K.O.Y.L.I. Was strong as a boy; measles at 7; no scarlatina or venereal history. A dental mechanic in civil life. Went to France,

June, 1916, and while in trenches suffered for two months from itching sores on legs, the pigmented remains of which we counted to the number of fifty-one. These were regarded as impetiginous. Was put on light duty back at headquarters. Two weeks later,having lost his appetite and feeling very seedy, his face began to swell, then the hands and feet. He developed hacking cough, sore throat, and was nauseated and vomited. The abdomen then swelled, pain was severe in all muscles, the abdomen, and across the loins. Marked constipation. Previous to these latter symptoms, and while on light duty at headquarters, he had nocturnal frequency, but never noticed any change in colour of urine. The œdema lasted fifteen days, and during some part of this time the systolic blood-pressure reached 200, and he was passing a slightly diminished amount of urine. Two weeks later there was a return of œdema—almost as badly as on the first occasion. The eyesight became blurred, and a month later the oculist reported "albuminuric retinitis of both eyes. Large area of retina involved, showing large atrophic spots more or less confined to the macular regions; also some small hæmorrhagic areas. Cannot see card at twenty feet." Six weeks later there were "comparatively few recent hæmorrhagic areas—most of them, particularly in the right eye, showing large areas of atrophy and pigmentation. Vision has improved immensely." Three months after onset he was feeling much better, but was pale, slightly puffy under the eyes, and had throbbing occipital headache in the morning. Sleeps badly and is very constipated. Heart normal in size; slight accentuation of second aortic sound. Systolic blood-pressure 150; urine—twenty-four hours' amount—42 ounces, specific gravity 1017, acid, smoky, albumin 0·3 per cent, urea 1·3 per cent, chlorides normal; many hyaline and granular casts, red blood and pus cells.

In several cases there has been slight and transient return of œdema of the face, particularly under the eyes, and also of the extremities, accompanied by a feeling of lassitude, muscular pains, and deep-seated loin pains. In such cases there is usually some increase of the albumin, and often of blood in the urine. A remarkable case in which œdema of the hands has persisted in spite of all treatment, and amelioration of other symptoms, is worthy of mention:—

No. 310856 Gnr. F.B., Canadian Field Artillery, was always previously healthy. A policeman in civil life, had previously been an iron-worker. Nephritis began with vertigo upon getting up in the morning. Then he noticed nocturnal frequency, and shortly developed frontal headache, insomnia, and gnawing pains in legs and arms, especially in the bones. Upon reporting sick albuminuria was found. Œdema of moderate degree in hands and feet only. No visual disturbances. Three months later there was still slight œdema of hands and feet of a brawny character such as one sees in myxœdema. Thyroid extract over a period of two weeks had no effect.

Upon exercise the swelling increases and diminishes after resting. Heart normal in size and function; second aortic sound not accentuated; blood-pressure normal. He had only slight dyspnœa. Urine—three months after onset—about normal in amount, twenty-four hours, acid, pale, specific gravity 1015, albumin 0·05 per cent, a few granular and hyaline casts, red blood cells and pus cells.

In almost all of our cases several complete examinations of twenty-four hours' specimens of urine were made, with measurements of the "day" and "night" amounts as well. As most of the patients were up, even though under careful

instructions to pass all urine into a specimen jar, it is certain that some was lost at stool, so that the amounts which we give are only relatively accurate. The average twenty-four hour urine for all cases was 1,465 cubic centimetres; the average "day" amount being 785 cubic centimetres, and the average "night" amount 703 cubic centimetres; in nineteen cases the amount passed at night was greater than that passed during the day. The urine was clear amber in colour in all but five cases, which at some time passed "smoky" urine. In the majority of the cases the amount of albumin found was only about 0·05 per cent. The chlorides were about normal in all cases, except one in which there was a transient decrease during an attack of migraine to which the patient had been subject for many years. The urea, which averaged for all cases about 0·12 per cent, was practically normal, in consideration of the fact that all were on restricted protein diets.

In conclusion, we find that almost all cases invalided to this hospital from a base hospital in France show, after a period of three months, a trace of albumin, a few granular and hyaline casts, red-blood cells and pus. The chlorides and urea are about normal. Nocturnal micturition is present in nearly forty per cent of the cases, and there is probably a slightly greater amount passed during the night between 8 p.m. and 8 a.m. than during the day. Many still complain of dyspnœa, slight headache, pains across the lower part of the back, and a few develop slight transient return of œdema. They are usually very well nourished, and not anæmic; in fact, there is usually a striking absence of the pale countenance so common in the ordinary nephritis of civil life. The blood-pressure is usually normal, and there is no enlargement of the heart. Structural retinal changes are rare, having been seen in only one of our series.

A striking feature has been the fact that in over half of our cases there has been at the onset acute catarrh of some part of the respiratory passage, most frequently a bronchitis, which was usually regarded as simply a "cold." It seems probable that a test for albuminuria at this stage would have revealed the exact nature of the malady, which as a rule was not diagnosed until either hæmaturia or œdema came on. Therefore, it seems reasonable to expect that in a locality where this infection is known to be prevalent, if all cases reporting sick with "colds" were subjected to a simple quick test for albuminuria, many cases of early nephritis would be brought under treatment then, which otherwise would return at a later date in a condition less favourable for quick recovery and return to duty.

SIX CASES OF KALA-AZAR.

(1) Their Treatment with Intravenous Injections of Tartar Emetic; (2) Notes on the Epidemiology.

By Major J. C. KENNEDY.
Royal Army Medical Corps.

(1) *Treatment with Tartar Emetic.*

The following six cases of kala-azar were discovered amongst the convalescents admitted to the Enteric Convalescent Depot, Naini Tal, during 1916. They were received in the ordinary course as convalescents from P.U.O. or one of the enteric group of fevers.

The diagnosis was in each case confirmed by puncture of the spleen and

examination of the spleen juice for the Leishman-Donovan bodies. As soon as the diagnosis was confirmed tartar emetic treatment was begun. At first a 1 per cent solution was administered intravenously; subsequently a 2 per cent solution was used as being more convenient, and as recommended by Colonel Sir Leonard Rogers, to whom I am indebted for kindly giving me the benefit of his experience. The effect produced by the treatment has exceeded one's most sanguine expectations. I feel that I am justified in stating that 5 out of the 6 have been permanently cured; unfortunately, 1 died as the result of an intercurrent attack of pneumonia. The essential details of each case are as follows:—

Case 1.—Cpl. A. W., "C" Company, Middlesex Regiment, aged 21. July 2, 1916: Spleen puncture, Leishmania present. Temperature in the evenings varying between 100° F. and 101° F., remitting in the mornings to normal. Liver enlarged slightly. Spleen enlarged to seven inches below costal margin in the nipple line. Red cells 5,350,000, white cells 5 480 per cubic millimetre. Weight 119 pounds. July 5: Intravenous injections of 1 per cent solution of tartar emetic begun. July 24: Attack of splenitis lasting three days with acute pain and temperature rising to 102° F. Spleen five inches below costal margin. July 28: Began using 2 per cent solution tartar emetic. August 4: Temperature now normal. Total tartar emetic administered up to date, 0·595 gramme. August 20 to 24: Developed a septic sore on the lip which spread for about one inch over the buccal mucous membrane. Fever lasted for four days and ran up to 102·4° F. Temperature is now normal and sore healing. November 2, 1916: Leucocyte count 4,800. January 3, 1917: Spleen just felt at costal margin. Weight 121 pounds. Total tartar emetic to date, 4·615 grammes. January 23: Spleen normal. March 20: Treatment stopped; total tartar emetic given, 6 515 grammes. July 2: Patient has been in perfect health ever since. Spleen normal. Leucocytes 8,600. Weight 123 pounds.

Case 2.—Lance-Cpl. L. H., "C" Company, Middlesex Regiment, aged 20. July 4, 1916: Spleen puncture. Leishmania present. Temperature of remittent type varying between 102° F. and 104° F. in the evenings and 99° F. to 101° F. in the mornings. Liver dullness 6½ inches in the nipple line. Spleen enlarged to four inches below the costal margin. Blood count, reds 6,200,000, whites 4,914 per cubic millimetre. Weight 134 pounds. July 6: Began intravenous injections of 1 per cent solution tartar emetic. July 17: Temperature normal. Total tartar emetic to date, 0·145 gramme. July 28: Injections with 2 per cent solution begun. Spleen three inches below costal margin. Since July 17, temperature has been somewhat irregular with occasional evening rises, but never above 100° F. August 11: From this date temperature remained normal. Total tartar emetic to date 0·945 grammes. September 3: Spleen only 1¾ inches below costal margin. Weight 147 pounds. October 16: Leucocyte count 6,562. Spleen felt only on deep inspiration. Weight 158 pounds. Total tartar emetic to date, 2·835 grammes. December 22: Last day of treatment. Total amount of tartar emetic given, 3·645 grammes. July 2, 1917: Patient has been in perfect health ever since. Spleen normal. Leucocytes 10,000. Weight 157 pounds.

Case 3.—Pte. J. B., "C" Company, Middlesex Regiment, aged 24. July 6, 1916: Spleen puncture. Leishmania present. Temperature remittent, 101° F. in the evenings and 98° F. to 99° F. in the mornings. Spleen five inches below

costal margin. Weight 109 pounds. July 9: Began treatment with 1 per cent solution of tartar emetic. July 26: Temperature is showing no improvement. Total tartar emetic up to date, 0·215 gramme. Treatment with 2 per cent solution begun. August 14: Temperature now normal. Weight 114 pounds. Total tartar emetic to date, 0·965 gramme. September 3: Spleen four inches below costal margin. Blood count, reds 4,997,000, whites 2,872 per cubic millimetre. October 27: Leucocytes, 3,125. November 11: Spleen three inches below costal margin. November 23 to 30: Had a severe attack of pneumonia which resolved by crisis on the evening of the 29th. December 9: No injections have been given since November 22. The spleen is not now palpable. The intercurrent pneumonic infection has probably contributed to the rapid reduction in the size of the spleen. January 3, 1917: The spleen can just be felt at the costal margin. During December only four injections were given. February 4: Leucocytes, 8,750. Five injections of five cubic centimetres each were given during January but they are now stopped. Total amount of tartar emetic given, 4·665 grammes. February 24: Weight 125 pounds. July 2: Patient had an attack of diarrhœa in June, but with this exception has been in good health. Spleen normal. Leucocytes 9,600. Weight 124 pounds.

Case 4.—Staff-Serjt. J. M., Grass Farms, aged 33. Condition before treatment begun—very anæmic and debilitated, weight 122 pounds, temperature high at times, fluctuating and irregular. Red blood cells 4,340,000, and leucocytes 5,400 per cubic millimetre. Spleen enlarged to three inches below the costal margin. Liver enlarged and measuring 9½ inches in the nipple line. July 12, 1916: Spleen punctured and Leishmania found in the smears. July 18: Treatment with tartar emetic begun in 1 per cent solution. July 28: No improvement in temperature which is still high. Injections with 2 per cent. solutions begun to-day. Total amount of tartar emetic to date 0·155 gramme. August 22: Temperature has been steadily falling and from to-day becomes normal. Total tartar emetic to date 0·915 gramme. From August 23 to October 6, injections of tartar emetic were given every three or four days. The temperature remained normal and the weight increased to 137 pounds. The spleen decreased in size two inches. October 7: An attack of acute perisplenitis with a temperature of 104·4° F. and acute pain. October 8: Temperature normal and pain much relieved. October 10: Spleen increased in size again and extends to three inches below costal margin. October 17: Sudden rise of temperature to 104° F. with pain in right side and right shoulder and symptoms of perihepatitis. November 10: Spleen is now 1¾ inches below costal margin and the liver has also decreased in size. Temperature has been normal since November 1, and the injections are again being regularly administered as they were stopped during the attacks of splenitis and hepatitis. January 3, 1917: Spleen four inches below costal margin. Temperature normal; weight 136 pounds. January 21: Condition the same. Weight 138 pounds. Pulse rapid but patient is able to be up all day. He eats and sleeps well. Antimony treatment continued. January 30: Developed pneumonia and expired suddenly from heart failure on Febuary 9. Altogether 5·215 grammes of tartar emetic were given intravenously. The patient's progress in the earlier stages of the treatment was most promising but latterly he remained in a more or less stationary condition. Though the fever was under control the spleen remained enlarged. There is no doubt that he had been suffering from kala-azar for a long time before his arrival

at Naini Tal and it is doubtful, quite apart from the intercurrent pneumonic infection, whether the treatment would have effected a complete cure.

Case 5.—Pte. J. M., "C" Company, Middlesex Regiment, aged 24. October 24, 1915 : Spleen punctured. Leishmania present. Temperature is high and remitting from 102° F. to 104° F. in the evenings to 98° F. to 100° F. in the mornings. Leucocyte count—2,725. Liver slightly enlarged. Spleen enlarged to four inches below the costal margin. October 27 : Intravenous injections of 2 per cent tartar emetic begun. November 9 : Liver enlarged to three inches below costal margin. Spleen 4½ inches below costal margin. Temperature the same but lower in the mornings. November 15 : As the temperature shows a tertian rise, quinine is given by the mouth and has a steadying effect. November 27 : From to-day the temperature becomes normal. Total tartar emetic to date—0·64 gramme. December 1 : Spleen three inches below costal margin. Weight 132 pounds. February 5, 1917 : Spleen four inches below costal margin. Weight 158 pounds. Total tartar emetic to date—2·73 grammes. March 24 : Spleen not palpable. Leucocytes 7,812. Treatment stopped. Total tartar emetic given—4·61 grammes. July 2 : With the exception of an attack of diarrhœa in June he has been in good health. Spleen normal. Leucocytes 8,200. Weight 152 pounds.

Case 6.—Pte. S. C., "A" Company, Middlesex Regiment, aged 26. January 19, 1917 : Spleen punctured. Leishmania present. Temperature in the evenings 101°F. to 103° F. and in the mornings 98° F. to 100° F. Leucocytes 5,625. Spleen 5¼ inches below costal margin. January 20 : Treatment with 2 per cent solution tartar emetic begun. February 5 : Temperature has been falling steadily and is now normal. Total tartar emetic to date, 0·30 gramme. Weight 126 pounds. April 7 : Leucocytes 9,375. Weight 144 pounds. April 13 : Last day of treatment. Total amount of tartar emetic given, 2·75 grammes. April 15—April 19 : Suffered from gumboil with rise of temperature to 103° F. April 27 : Leucocytes 7,031. Spleen not palpable. May 13 : Weight 150 pounds. July 2 : He has been in good health ever since. Spleen normal. Leucocytes 11,000. Weight 175 pounds

SUMMARY.

Condition before treatment	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Leucocytes	5,480	4,914	2,872	5,400	2,725	5,625
Size of spleen below costal margin	7 in.	4 in.	5 in.	3 in.	4 in.	5¼ in.
Weight—lbs.	119	134	109	122	132	126
Temperature became normal in days	31	36	36	35	30	17
Grammes of tartar emetic injected	0·595	0·945	0·965	0·915	0·64	0·3
Spleen became normal in days	190	100	180	—	150	90
Total amount of tartar emetic administered—grammes	6·515	3·645	4·665	5·215	4·61	2·75
Weight gained—lbs.	2	22	16	—	26	24

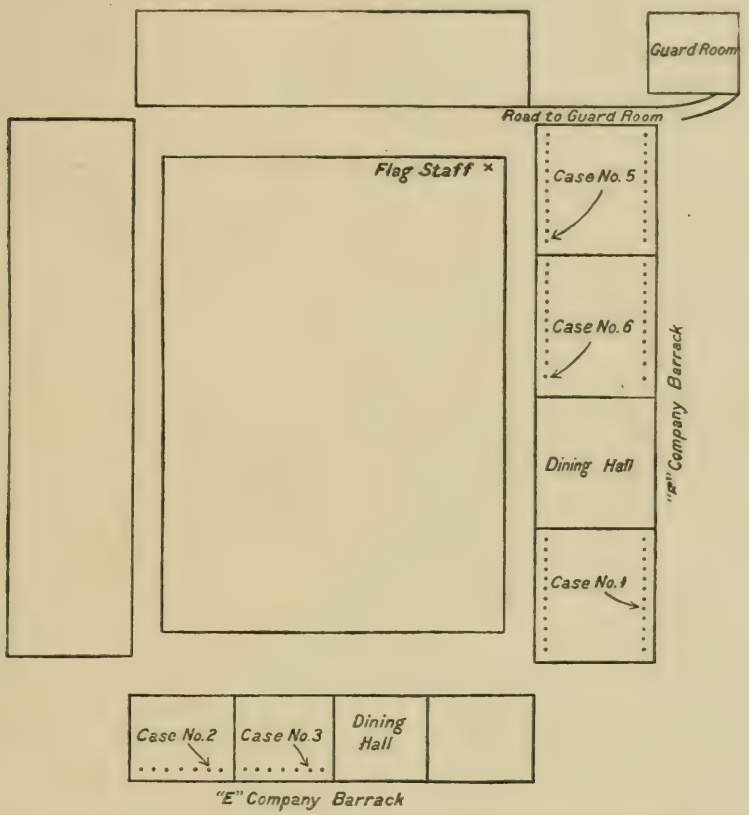
A few remarks on the treatment may be of interest.

The injections are given with a large all-glass syringe into one of the veins at the bend of the elbow which is made prominent by means of pressure on the upper arm applied by an assistant. To make sure that the point of the needle is inside the vein, some blood is drawn up into the syringe, and this also gets rid of any air that may have lodged in the needle. The escape of any of the antimony solution

into the surrounding tissues must be carefully avoided, otherwise much local irritation and pain is produced, and sloughing may result.

The injection should not be given just before or immediately after a meal.

It has been my practice to begin with 2 cubic centimetres of the 2 per cent solution, and gradually increase the dose by ½ cubic centimetre every second day until a dose of 4 or 5 cubic centimetres is reached. The interval between each dose is then lengthened to two or three days.



PLAN NO. 1.—Dum Dum, December, 1914, to February, 1915.

In three of my cases I was unable to give a larger dose than five cubic centimetres without producing rather distressing symptoms. Two of the cases were able to stand seven cubic centimetres well, viz., Nos. 5 and 6, and these were the two that responded most quickly to the treatment.

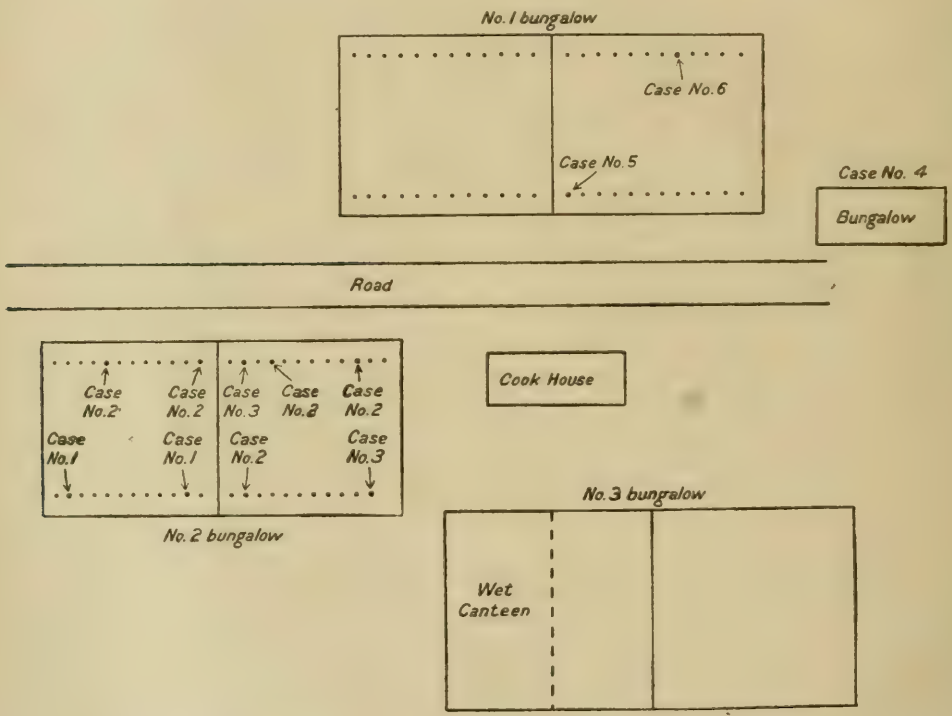
The symptoms produced by a maximum dose are immediate and almost unbearable tickling in the throat accompanied by a short dry cough and sneezing. A little later a feeling of sickness may supervene. The patient soon learns to exercise a little self-control, and lie absolutely still on his back until this discomfort has passed off. For some hours after, the patient feels "unsettled," and, perhaps, irritable, and occasionally a headache supervenes. Most of the patients complained

of aching of the teeth. Very rarely the feeling of sickness was succeeded by retching, and even vomiting.

When the temperature became normal, the patient's maximum dose was administered twice weekly, and when the spleen became normal, the dose was given once a week for about a month.

(2) *Notes on the Epidemiology.*

Five of these cases belonged to the same regiment—the Middlesex. The regiment arrived in India in December, 1914, and proceeded to Dum Dum. One man belonged to "E" Company, three to "F" Company, and one to the Signal section. For the two months during which they were stationed in Dum Dum, they occupied barrack-rooms, as shown in Plan No. 1.



PLAN No. 2.—Barrackpore: Plassey Barracks, February 20 to December 10, 1915.

A fortnight was then spent in a camp at Jafferpore, and subsequently Cases 1, 2, 5, and 6 proceeded to Barrackpore about February 20, 1915. When "E" and "F" Companies were amalgamated into "C" Double Company, the fifth man (Case 3) joined the others at Barrackpore in June, 1915.

The barrack-rooms and the position of the beds occupied by these men during their stay in Barrackpore is shown in Plan No. 2. It will be noticed that several of them did not occupy the same bed during the whole time. They remained at Barrackpore till the middle of December, 1915; thence they proceeded to Dinapore,

but remained there only about a month, and on January 24, 1916, arrived at Rawal Pindi.

Case 1 was admitted to hospital on February 22, and transferred to Naini Tal on April 6, and diagnosed kala-azar on July 2.

Case 2 was admitted to hospital on February 1, and transferred to Naini Tal as a convalescent on May 19. Reported sick with fever on January 26, and diagnosed kala-azar by spleen puncture on July 4.

Case 3 was admitted to hospital on April 14, and transferred to Naini Tal on May 25. Diagnosed kala-azar by spleen puncture on July 6.

Case 5 was in hospital for four days in February suffering from fever, supposed to be malaria, but no parasites were found in the blood. In the beginning of June he was seized with a continuous high fever, admitted to hospital on the 8th, and transferred to Naini Tal on August 12. Diagnosed kala-azar by spleen puncture on October 24.

Case 6 was admitted to hospital for broncho-pneumonia on May 5, and re-admitted on June 19 with a continuous high fever, and transferred to Naini Tal on August 12. Diagnosed kala-azar by spleen puncture on January 19, 1917.

The sixth case (No. 4) was a staff-serjeant who had served for ten years continuously in India, chiefly in Bengal. From April, 1913, to December, 1915, he served in Barrackpore, and during that period spent seven months in the Sunderbunds. He was a married man, and lived in the bungalow shown on Plan No. 2.

In July, 1915, he suffered from malaria, which resisted treatment, and he was transferred to Rawal Pindi on account of his health. Immediately after his arrival in Rawal Pindi in December, 1915, he had to be admitted to hospital suffering from malaria complicated with severe colitis. He became critically ill, and though kala-azar was suspected, he was diagnosed enteric fever. He was transferred to Naini Tal on May 4. Kala-azar was diagnosed by spleen puncture on July 12.

There would seem to be no doubt that all the six cases contracted the disease at Barrackpore. Further, I am given to understand that since the discovery of these cases which I duly reported, others from the same regiment have since been diagnosed in Rawal Pindi.

It would be of interest if the particulars of these cases could also be published with a view to piecing together all the facts of this epidemic.

CLINICAL TYPES OF SUBTERTIAN MALARIA, AS SEEN IN SALONIKA IN SEPTEMBER, OCTOBER, AND NOVEMBER, 1916.

By Major A. W. FALCONER.
Royal Army Medical Corps.
AND
Captain A. G. ANDERSON.
Royal Army Medical Corps.

During September, October, and November we have had an opportunity of seeing over 3,600 cases of malaria. The diagnosis of malaria has been founded either on a positive blood finding, or on the history of the case, temperature chart, and a definitely hard palpable spleen. In a small proportion of the cases other infections were present, in addition to malaria. In isolated cases a double infec-

tion with subtertian and quartan parasites was found. Owing to the fact that in some forty per cent of the cases we were unable to demonstrate the parasites in the peripheral blood-stream, we are not in a position to give exact figures of the relative amounts of benign to subtertian infections, but there can be no doubt that during this period the percentage of subtertian infections was very high. The relatively high proportion of the negative blood finding is due to the fact that practically all the patients were under the influence of quinine on admission to the hospital, and many of them had been several days under hospital treatment before admission to a base hospital. Further, owing to the pressure on the beds, it was generally impossible in the less severe cases to make more than one blood examination.

The chief types of subtertian malaria seen during this period were as follows:—

The majority of the cases were of the simple subtertian, double subtertian, and irregular types of subtertian pyrexia, without local manifestations. These cases uniformly responded well to treatment with quinine.

The most important group of cases with local symptoms, both on account of relative frequency and on account of the difficulty of the differential diagnosis, were characterized by more or less urgent gastro-intestinal symptoms. This group could be separated into several more or less definite types.

Dysenteric.

A large number of the cases were sent into hospital with a diagnosis of dysentery. A prominent symptom of these cases was the presence of diarrhœa. The great majority of the patients stated that they were passing "blood and slime"; but it must be remembered that this is a mere formula with most of them, and of no value in diagnosis. In most of these cases the stools were fluid fæculent stools without definite blood or mucus, and they varied in number from six to fifteen or more in twenty-four hours. These cases rapidly improved under quinine treatment.

In a smaller number of cases the stools contained definite blood and mucus. It was possible in the great majority of these cases to demonstrate a superadded infection with one of the organisms of the dysenteric group. In a few other cases patients admitted with malaria, but without dysenteric symptoms, developed genuine bacterial dysentery; and, again, cases with bacterial dysentery, after a few days in hospital, showed genuine malaria with protozoa in the blood.

In a few cases where the diarrhœa tended to persist, concurrent infections with *Lamblia intestinalis*, *Tetramitus*, *Trichomonas*, and *Balantidium coli* were demonstrated.

Apart altogether from these cases, however, there were a considerable number of patients admitted whose dominant symptom was diarrhœa, and in whom repeated examinations of the stools failed to demonstrate any dysenteric organisms or amœbæ. Several of these cases died, and the autopsy showed, in some, slight congestion of the colon chiefly in its upper part; in others definite small submucous hæmorrhages; and in one, to be described in detail, extensive submucous hæmorrhages, but a perfectly intact mucous membrane. In many of these cases the bowels moved at first from twenty to thirty times a day. The stools were liquid fæculent stools, not unlike Worcester sauce. In the majority this diarrhœa very speedily subsided under energetic quinine treatment. In some the stools were fæcal, liquid, more or less heavily tinged with blood, and very

characteristic—notably bile stained. This stool, although containing blood and traces of mucus, is yet macroscopically quite distinct from the typical dysenteric stool. As examples of those types we may quote the following cases:—

Cpl. F., aged 32, admitted on September 20, 1916, with profuse diarrhœa and pyrexia. The bowels were moving about every hour. The stools were fluid, fæculent, and heavily tinged with bile and blood. The spleen was enlarged and hard, and the blood-film showed a very heavy infection, with subtertian parasites of all types, rings, rosettes, and crescents. He was treated with intravenous quinine and salines. The stools were examined for organisms of the dysenteric group and protozoa with a negative result. The diarrhœa continued, the stools constantly containing blood and traces of mucus. Ultimately the patient became incontinent, and died eight days after admission.

Post-mortem.—The spleen was enlarged to four times its normal size. The large intestine showed moderate congestion with small punctate submucous hæmorrhages. There was no ulceration, and the whole mucous membrane was smooth and glistening.

Serjt. B., aged 24. He was sent into hospital on September 2, 1916, with a history of having been unwell for nine days, at first with constipation, abdominal pain and vomiting. Three days before admission he began to suffer from severe diarrhœa. On admission, the patient was collapsed, and the bowels were moving every half hour. The stools were liquid, fæculent, and heavily stained with blood and bile. There was marked icteric tinging of the sclerotics. The blood showed the presence of numerous subtertian rings. The diarrhœa continued, and ultimately the motions appeared to consist of almost pure blood.

Post-mortem.—The whole of the large bowel showed a macroscopically intact smooth glistening mucous membrane without any suggestion of ulceration. Extensive submucous hæmorrhages were present throughout the whole of the large bowel.

Choleraic Pernicious Fever.

Fortunately only two cases of this type were met with. Both of these cases died within fifteen hours of admission in spite of intravenous quinine and salines.

Pte. K., admitted on September 14, 1916, from a camp alongside our lines. On admission, the patient was in a state of profound collapse, with subnormal temperature, sunken cheeks, blue nails, and cold cyanotic extremities. Mentally the patient was dull, and it was difficult to get a history, but it appeared that he had not been well for two days, although he remained on duty till the day of admission. Parasites were not found in the blood-films. There was incontinence of fæces and a watery brown fluid, without visible blood or mucus, continued to ooze from the anus. He died within twelve hours of admission to the hospital.

Post-mortem.—The spleen was slightly enlarged, and almost diffluent. The colon and sigmoid flexure presented moderate congestion, but no trace of ulceration. Smears from the spleen, after a prolonged search, showed rings and crescents of subtertian malaria.

The second case was exactly similar, except that it was a second attack, and that the parasite was readily found in the blood.

Appendicular Type.

Cases strongly suggesting appendicitis have not been very infrequent. In all we have seen some twelve cases of this type. In these cases the chief complaint

was vomiting, and severe pain referred to the right iliac fossa, associated with moderate pyrexia and marked tenderness and rigidity in the right iliac fossa. In most of the cases it was possible to show that the rigidity was not constant. In some of the cases the tenderness was most marked somewhat above McBurney's point. In others it corresponded accurately with this point. In all of our cases we were able to demonstrate either the presence of the parasite in the blood, or a definite enlargement of the spleen. None of our cases showed a leucocytosis, and all had the typical relative lymphocytosis of malaria. All rapidly cleared up under quinine treatment. We have also seen a few cases in which the abdominal pain and rigidity were so marked and so diffuse as to suggest an acute abdomen, but these also rapidly cleared up under the use of quinine, with the exception of one case, which was complicated with septicæmia. This, at the autopsy, showed a purulent pleuritis and peritonitis, in the exudates of which streptococci were demonstrated.

Bilious Remittent Fever.

Thirteen, or fifty per cent of our fatal cases, were of this type. These cases had all been ill several days before admission to the base hospital. On admission, they were collapsed, with marked yellowing of the conjunctivæ and a peculiar earthy facies. They suffered much from almost constant vomiting, and the majority from bilious diarrhœa and mental confusion. After treatment by intravenous quinine and intravenous saline, they improved from a condition of apparently extreme urgency to one of relative comfort, but, unfortunately, the improvement was not maintained, and after a period of from two to five days their condition again became critical. The jaundice became deeper, the vomiting, often accompanied by uncontrollable hiccough, again became severe, the bowels incontinent, the temperature rose, and they died in coma or delirium.

Post-mortem.—The chief macroscopic features were enlargement of the spleen and submucous hæmorrhages in various organs, and the presence of a gall-bladder distended with thick dark bile.

Pernicious Fever with Pulmonary Symptoms.

Both numerically and as a cause of death, the next most important group was that in which the patients' dominant symptoms were referred to the respiratory tract. Of twenty-six cases of malaria which terminated fatally, pulmonary complications of a pneumonic or broncho-pneumonic character were present in seven, and were the immediate cause of the fatal issue.

Amongst the patients admitted to the hospital were a large number who complained of respiratory symptoms, and some who were admitted under the varying diagnosis of bronchitis, broncho-pneumonia, and congestion of the lungs, were found subsequently to be suffering from subtertain malaria. In them the malarial parasite could be demonstrated in the blood.

Amongst these cases were a small proportion who, in addition to their malaria, gave a history and presented the physical signs of a chronic bronchitis and emphysema, and in them the occurrence of a malarial attack caused a decided increase in their symptoms and physical signs.

In the majority of cases, however, there was no history of bronchitis nor any evidence of emphysema. Amongst these the pulmonary complications could be divided into the bronchitic, the broncho-pneumonic and pneumonic.

The Bronchitic.

The patients complained of pain and tightness in the chest with persistent cough accompanied by expectoration. They presented the ordinary signs of a diffuse bronchitis with numerous rhonchi and râles scattered all over both lungs. Some showed the typical malarial pyrexia, others an irregular intermittent pyrexia, while others ran a normal or subnormal temperature throughout their stay in hospital. They differed from an ordinary bronchitis only in the presence in the blood of the malarial parasite, and their rapid response to treatment by quinine. It is not suggested that the bronchitis is caused by the malarial parasite, and it may be that the bronchitis is nothing more than that which is usually associated with the onset of any acute febrile illness. Nevertheless the respiratory symptoms are so well marked and the patient's complaint is so entirely referred to his chest that one is, we think, justified in separating out a definite clinical group—the bronchitic.

Pneumonic and Broncho-pneumonic.

The term pneumonic is not strictly accurate for the whole of this group of cases, and all that it is meant to convey is that we are dealing here with a group of cases in which the physical signs suggest that there are in the lungs areas of more or less extensive consolidation, some definitely lobar, others lobular or confluent lobular. To this group belong the fatal cases already referred to. In all of these seven cases subtertian parasites were demonstrated in the blood, and in all were definite physical signs, in some lobar, in others lobular consolidation.

Lobar Consolidation.

Of these seven cases at autopsy four showed definite lobar consolidation of one or more lobes, complicated in two cases by hæmorrhagic pleurisy. These showed the ordinary macroscopic appearance of lobar pneumonia in the grey hepatic stage.

Lobular Consolidation.

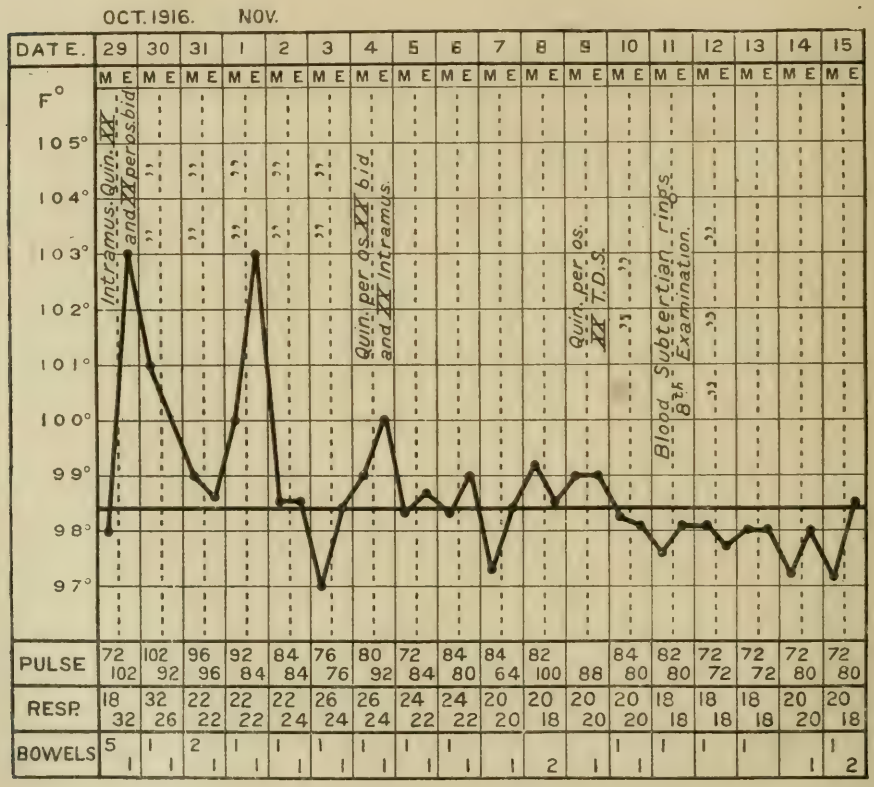
In the other three cases there was extensive lobular consolidation of both lungs. In one case there was present, in addition to the broncho-pneumonia, twelve ounces of blood-stained serous fluid in the pleural cavity.

In both these groups we would appear to be dealing with a superadded infection in which the malarial parasite was at the most but a predisposing cause. It is worthy of note, however, that during this period only one case of pneumonia unassociated with malaria was admitted.

A third group comprised a series of cases which from the onset of the illness presented definite pulmonary physical signs and symptoms which pointed to areas of definite consolidation in the lungs, though the course of the disease was not that of a true lobar or lobular pneumonia. Two cases will be described in detail. In both subtertian parasites were demonstrated in the blood.

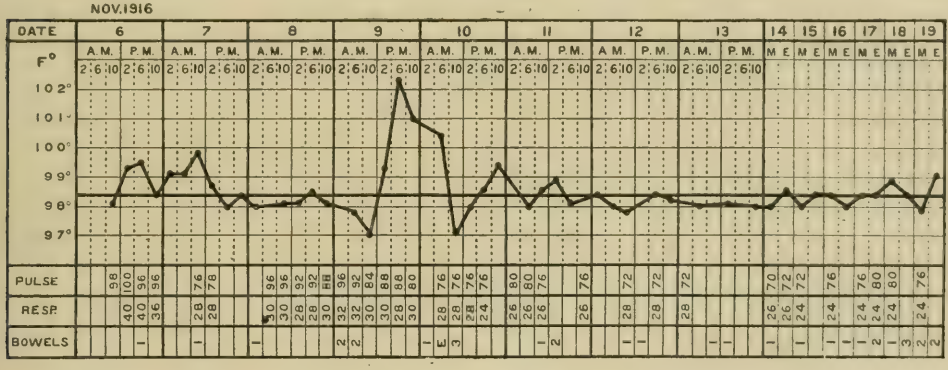
Private F., aged 20, reported sick on October 22, 1916, complaining of shivering, malaise, and diarrhœa. Admitted to hospital on October 29, 1916. He was pale, with a slight icteric tint of the sclerotics. The spleen was three fingers' breadth below the costal margin. Over the left lower lobe posteriorly there was evidence of consolidation with bronchial breathing and numerous medium-sized moist râles. Anteriorly there was bronchial breathing in the second, third and

fourth left intercostal spaces. There was no definite dullness on percussion either anteriorly or posteriorly, and the vocal resonance and fremitus were not markedly increased. The lung condition remained practically unchanged until November 13, 1916, when the breath sounds lost their bronchial quality, became a little weak, and a friction rub developed over the left lower lobe posteriorly. On the day of admission the temperature rose to 103° F., his pulse to 112, and his respirations to 32. Next day the temperature did not rise above 99° F., but on the following day again rose to 103° F. It fell again on the subsequent day and remained normal from that point onwards. The pulse respiration ratio was not at any time much disturbed. There was little cough and no expectoration. He was treated with twenty grains of quinine intramuscularly twice a day for the first six days, and then by twenty grains intramuscularly and forty grains by mouth for the next seven days.



Lance-Cpl. I., aged 29, reported sick on November 1, 1916, complaining of pain in the chest, headache and shortness of breath, no shivering. On November 4, 1916, he was admitted to hospital with a diagnosis of congestion of the lungs. He did not have the general appearance of pneumonia nor did he look very ill. Dyspnœa was evident only on exertion. The spleen was just palpable. The whole of the right lung was involved. Anteriorly the breath sounds above and

below the clavicle were bronchial, and all over the anterior aspect of the lung were numerous moist, sticky râles. The movement was diminished but there was no appreciable percussion dullness. Posteriorly there was slight percussion dullness over the right supraspinous fossa and over the right base. The breath sounds over the supraspinous fossa were bronchial and distinctly tubular in a small area just below the spine of the scapula. Numerous râles were present all over the right lung and a few râles at the left base. On admission his temperature was 99·8° F., his pulse 96, and his respiration 36. On the following day the temperature was again 99·8° F., falling on the third day to normal. On the fourth day his general condition became worse. The temperature rose to 102·8° F., and for two days the patient lay in a curious state of wandering delirium. His temperature fell on the following day and did not rise above 99° F. at any other period of his illness. During the sudden rise in temperature the pulse was 84, and the respirations 30, showing a distinct disturbance of the pulse respiration ratio. The signs over the right side of the chest gradually diminished, but on November 12, 1916, without any rise of temperature or any increase in the patient's symptoms, a large area of consolidation was found over the left lower lobe posteriorly accompanied by numerous moist râles. On November 27, 1916, the right lung was completely clear but the left lower lobe still showed bronchial breathing and râles. At no time was there any expectoration. Treatment was carried out with quinine by mouth.



These cases have been detailed because, although the chest signs and symptoms were perfectly well defined, suggesting a lobular consolidation, the course of the disease was certainly not that of lobular pneumonia. One of the cases showed a disturbance of the pulse-respiration ratio, the other did not. Neither case had any expectoration. In neither case was the temperature chart that of a pneumonia, but was certainly characteristic of a malarious attack. In both cases subtertian parasites were found in the blood. The character of the pulse remained good throughout the course of the disease and at no time were the patients seriously ill.

It is difficult to suggest what the exact pathological condition in those cases is, but we believe that there is a definite clinical type of malaria associated with the physical signs of more or less extensive consolidation of the lungs, in which there is no evidence whatever of a superadded infection. This type may be conveniently designated the pneumonic.

Cerebral Cases.

An extremely interesting but relatively small group of cases presented cerebral symptoms of the well recognized cerebral types, but, as we intend to describe these later in detail from the point of view of treatment, we will only briefly mention them here. In all we have had nine cases in which the dominant symptoms have been due to local affections of the nervous system. Two of these were of the bulbar type and showed temporary paralysis of the muscles supplied by the bulbar nuclei; both recovered and were discharged from the hospital without any evidence of organic disease. One patient was admitted with a diagnosis of debility. Twenty-four hours after admission he suddenly became comatose and remained so for fifteen hours. He also completely recovered. One patient twenty-one hours after admission, while in the latrine, developed an epileptiform fit. These fits, which were of a general epileptiform character, were repeated about twelve times in the following twenty-four hours. The left leg became somewhat weaker than the right and developed an extensor plantar reflex which at the time of writing is still present. In addition the patient still presents definite nystagmus and a tendency to a reeling gait, but no evidence of active disease.

In four cases the most marked symptom was violent delirium which persisted for several days uninfluenced by variations in the temperature. In three of the cases there was a high intermittent pyrexia, in one the temperature was never above 99° F. In all the cases subtertian parasites were demonstrated in the blood and all the cases completely recovered. One patient presented meningitic symptoms associated with pneumonia at the right base. This patient died. The autopsy showed a considerable excess of cerebrospinal fluid beneath the tentorium with œdema of the pia-arachnoid over the base, and congestion of the vessels over the pons. Section of the brain after hardening in formalin showed no evidence of gross brain disease. The middle and lower lobes of the right lung presented the features of an ordinary croupous pneumonia.

Generalized Œdema with Ascites.

Two cases were admitted complaining of breathlessness, and generalized œdema.

Driver W., aged 35. Reported sick on October 6, 1916, complaining of breathlessness, swelling of the feet, legs and face, and headache. Admitted to hospital on October 9. On admission there was considerable œdema of the hands, feet and legs, and the eyelids were puffy. The visible mucous membranes were almost colourless, and there was some lemon-coloured tinting of the sclerotics. The abdomen was tolerably distended, the subcutaneous tissues were œdematous and there were all the characteristic signs of a considerable accumulation of free fluid in the peritoneal cavity. The spleen extended almost to the umbilicus. The liver was not enlarged. There was a slight mitral systolic murmur, the rate of the pulse was 78, and the rhythm of the heart was normal. The apex beat was in the fourth space in the nipple line. Nothing abnormal was made out in the lungs; the urine was of a specific gravity of 1012, clear straw coloured. It did not contain albumin, bile or sugar. The deposit showed a few uric acid crystals but no casts. The temperature was normal on the day of admission, October 9, 1916, but rose to 103° F. on the evening of the 10th, to fall

on the morning of the 11th to 99·8° F. From the 15th onwards the temperature remained normal. A blood-film showed the presence of subtertian rings and crescents. Treatment by intravenous quinine was commenced on the 10th, and later continued intramuscularly and by the mouth. On the 12th the condition of the patient was immensely improved and the œdema of the feet and hands had almost disappeared and it was no longer possible to demonstrate free fluid in the abdominal cavity. On the 16th the blood was free from parasites and he was discharged to hospital ship on the 23rd.

Private B., aged 25, reported sick on October 27, 1916, complaining of swelling of the legs and breathlessness. Previous to the present illness he had always been healthy. He was admitted to the hospital on October 27. On admission the patient presented notable œdema of the legs and of subcutaneous tissues of the back and abdomen and the eyes were puffy. The visible mucous membranes were pale and there was a slight lemon tint of the sclerotics. The abdomen was considerably distended and gave all the characteristic signs of free fluid in the abdominal cavity. The spleen extended almost to the umbilicus and the lower margin of the liver was ½ inch below the costal margin. The apex beat of the heart was in the fifth space almost in the nipple line. The pulse-rate was 96 and the rhythm normal. The second pulmonic sound was not definitely accentuated. Nothing abnormal was made out in the lungs. The urine did not contain albumin or casts. The blood-film showed the presence of subtertian crescents and rings and the red blood cells showed marked anisocytosis and polychromatophilia. The temperature was normal and remained so. The patient was treated at first with intramuscular quinine, and later with quinine by mouth. By November 11, the œdema of the extremities and the physical signs of ascites had completely disappeared. He was discharged to a hospital ship on November 15.

In these two cases we have the presence of œdema of the face and extremities and notable ascites without any evidence of either primary heart or renal disease. Both cases showed the presence of subtertian parasites and both very rapidly cleared up under quinine treatment. Apart from the absence of any evidence of heart disease the distribution of the œdema, affecting the face, and the presence of a notable amount of ascites without enlargement of the liver is sufficient to exclude a cardiac origin for the œdema. Similarly the presence of a perfectly normal urine in both cases excludes a renal origin. We would suggest that the œdema is of toxic vascular origin similar to the œdema and ascites seen in the late stages of multilobular cirrhosis of the liver.

Gangrene of the Feet.

Another group consisting of three cases showed evidence of local vascular changes in the development of gangrene of the toes.

Pte. B., A.S.C., aged 26, admitted to the hospital on October 4. He reported sick on October 1, complaining of loss of the use of his legs and numbness of his feet. He stated that he had not been unduly exposed before reporting sick. On admission to the hospital the temperature was 102° F., the conjunctivæ were slightly icteric and the spleen was palpable. A blood-film showed the presence of numerous subtertian parasites. He complained of very severe pain in both feet shooting up the legs, both feet were considerably œdematous and over the

dorsum of each foot was a large purple ecchymosis. The great toe and all the smaller toes of the right foot and the small toes of the left foot were slightly swollen and almost black in colour. On the soles of both feet, from the bases of the toes backwards for a distance of about one inch, the skin was purple in colour. Sensation to gross touch was still present, the dorsalis pedis and posterior tibial arteries of both feet could be felt pulsating quite strongly. As it was considered possible that a vascular spasm aggravated by quinine might be a factor in the condition, the patient was not given quinine but was treated with four grammes galyl intravenously. Next morning the temperature had fallen to normal and remained so for the remainder of the patient's stay in hospital. The patient's general condition generally improved and the blood was reported negative to malaria on the 10th. The feet rapidly improved, and apart from slight superficial necrosis on the dorsum of the right foot completely recovered. On October 14 he was put on twenty grains quinine sulphate daily by mouth and was discharged to hospital ship on October 28.

Pte. M., aged 24, admitted to hospital on October 11. He reported sick on October 5 complaining of shivering, pains in the head and back. For three weeks before reporting sick his company had been resting behind the line. On October 7 when taking off his boots he noticed that his feet were cold and that his toes were blue. He found that he was unable to stand on his feet on account of pain, and because "he could not feel his feet." On admission to the hospital his only complaint was pain in his feet. He presented distinct icteric tinging of his sclerotics and his spleen was palpable. Both feet showed discoloration of the toes, the left foot being more affected than the right. All the toes of both feet were affected, the colour varying from brownish purple to purple. On the left foot the plantar surface of all the toes showed small bullæ, on the right foot only the larger and third toes presented bullæ. The dorsalis pedis and the posterior tibial arteries of both feet could be readily felt pulsating. Patient was put on one drachm quinine sulphate daily and steadily improved. Both feet recovered without any loss of tissue.

Drvr. W., aged 21, admitted to the hospital on October 9 with a diagnosis of malaria. He reported sick about ten days before admission to the base hospital on account of shivering and pain in the head and back. On the second day of admission to a field ambulance, the feet become very cold and continued so in spite of hot bottles. On the next day the feet were seen to be blue. On admission to the base hospital there was considerable œdema of both feet, all the toes of both feet were blue with large bullæ, especially on the right big and second toes, extending for some distance over the dorsum of the feet. Several of the bullæ were burst and were discharging a seropurulent fluid. The dorsalis pedis and posterior tibial arteries could be felt beating quite strongly in both feet. There was marked icteric tinging of the sclerotics and the spleen was palpable one inch below the left costal margin. A blood-film showed no malarial parasites. The patient on admission was given an intravenous injection of four grammes galyl and ten days later was put upon quinine. The patient's general condition rapidly improved, but considerable sloughing occurred over the dorsum of the large and second toes of the right foot, involving the loss of the nail of the great toe and opening into the first interphalangeal joint of the second toe. There was also slight superficial sloughing over the dorsum of the left large toe.

Thirty cases infected with malaria have died. Of these, one was a case of subtertain malaria who was quite convalescent from malaria when he developed an extremely septic throat followed by pneumonia.

Post-mortem.—There was ulceration of the pharynx and epiglottis with septic consolidation of both lower lobes of the lungs. In two cases there was in addition to malaria a Shiga dysentery and the patients died of running dysentery. Post-mortem in both cases almost the entire mucous membrane of the whole of the lower bowel and the lowest two feet of the ilium were destroyed.

Fig. 3.

Mortality and Post-mortem Findings.

One case died of amœbic dysentery and septicæmia. The mucous membrane of the lower bowel was much destroyed and there were abscesses in both kidneys. Four cases died of lobar pneumonia affecting one or more lobes. In one of those there was in addition an extensive hæmorrhagic pleural exudate. In those cases malaria was not the cause of death. This leaves twenty-two cases with a total case mortality of 0·61 per cent. Three cases presented at the autopsy extensive lobular consolidation of the lungs, complicated in one by hæmorrhagic pleurisy. The immediate cause of death in those cases was also probably the lung condition, and it is a debatable question whether they represent a double infection or a true complication of malaria. Two cases died of septicæmia. One was admitted to hospital with a septic arm following an intramuscular injection of quinine. At the autopsy pyæmic abscesses were found in the lungs and kidney and recent vegetations on the mitral valve. One was admitted in an extremely collapsed condition with numerous septic sores on both arms and developed signs of pleural and peritoneal effusion. At the autopsy there was found a right-sided septic pleural effusion and septic peritonitis. Streptococci were recovered from the pleural and peritoneal fluids.

Excluding those five cases we have seventeen cases of uncomplicated malaria at a mortality of 0·47 per cent.

In one case the autopsy disclosed moderately advanced granular kidneys, and

in one case a right-sided hydronephrosis which had largely destroyed the right kidney.

We take this opportunity of thanking Colonel Purves Stewart, C.B., A.M.S., Consulting Physician to the Salonika Forces, for his valuable assistance and advice which was always at our disposal during this period. To Lieutenant-Colonel Mitchell we are also indebted for permission to use the hospital records, and to Captain Richards, R.A.M.C. (T.F.), for the hæmatological and bacteriological and post-mortem reports.

MEMORANDUM ON THE TREATMENT OF PAINFUL SHINS FOLLOWING TRENCH FEVER, BY ELECTRO-THERAPEUTICAL METHODS.

By Captain A. J. H. Iles.

Royal Army Medical Corps (T.F.).

Officer in Charge of X-ray and Electro-therapeutical Department, General Hospital, British Expeditionary Force, France.

Every physician connected with troops on active service knows the condition which is now officially diagnosed as "trench fever."

He also knows that were it not for the "painful shins," which almost invariably follow, the vast majority of "trench fever" cases would be fit for duty in a very short space of time, whereas, in fact, thanks to these "painful shins," the convalescent stage of the disease is very long and disappointingly prone to exacerbation.

During the early part of this past winter I tried many things electrical for the relief of this condition, watching the cases in their wards, as well as in the electro-therapeutical department, and by the end of November I had come to the conclusion that the remedy par excellence was ionization combined with faradism.

My method is as follows:—

Using liquor iodi fort., a patch 1½ inches wide and 3 inches long is painted, well outside and parallel with the anterior border of the tibia, in the middle third of the leg, and ionized for ten minutes, at a maximum of ten milliamperes, the negative electrode being placed over the painted area, a thick pad well soaked with two per cent sodæ salicylatis in three per cent sodium chloride being placed between.

On the second day, ionization, with sodium chloride only, is applied over the original site, the negative electrode being placed as before. Ionization is now stopped, and for the next three and subsequent days the muscles of the calf and leg are exercised for ten minutes daily with faradism.

As a rule the men tell one at their second or third visit that they have experienced immediate relief from pain; that they have slept better and feel much better in themselves, and where they do not do so the fact soon becomes obvious from their general appearance.

I watched the earlier cases for some weeks, keeping them to see if there was any tendency to recurrence, and having satisfied myself that there was not, I then proceeded to carry out the above course as a routine.

Below are the statistics of 100 consecutive cases received here from the wards for treatment.

Days under treatment	Number of cases
1	0
2	3
3	6
4	14
5	11
6	14
7	10
8	15
9	2
10	12
11	1
12	2
13	
14	3
16	1
20	1
21	1
22	1
Sent to England as unlikely to be well in three weeks	2
Average stay under treatment = 7·50 days.	100

It will be noted that two per cent were sent to England after treatment had been begun, owing to slow recovery, and that ninety-eight per cent were sent to duty "A," or convalescent depot, the latter means of evacuation being only used where it was thought that the man's general condition required a little longer rest.

I do not mean to write the history of this department, established under authority in May, 1915, until after its work is completed, but viewing the number of cases of "trench fever" which have hitherto spent weeks or months in hospital, and seeing the immediate and apparently lasting results of the above simple line of treatment, I take the liberty of putting it forward.

A METHOD OF STAINING BLOOD-FILMS

By Corporal J. L. YULL, B.Sc.
Royal Army Medical Corps.

The following method of staining blood-films has been found to give good results:—

(1) Cover the film with absolute alcohol for fifteen seconds, pour off the alcohol and wave the slide vigorously to dry it.

(2) Stain with dilute Manson's methylene blue for thirty seconds. Use a three per cent solution of the concentrated stain.

(3) Pour off the blue, and, without washing the slide, stain with very dilute eosin (a 0·025 per cent solution) for thirty seconds, and pour off the stain.

(4) Wash with distilled water for thirty seconds, and dry between sheets of blotting-paper.

The structure of leucocytes is brought out with excellent definition and colour

contrasts. Blood platelets and the very fine filaments connecting the nucleus lobes in "polymorph" cells show up with special clearness. The value of Manson's blue as a stain for the malarial parasite is added to by the use of eosin.

The strengths and times recommended above may be taken as applying in all cases of ordinary routine blood examination, such as the differential leucocyte count or the search for parasites. But if finer results are desired they may be obtained at the expense of rapidity by diluting the blue and eosin ten times and allowing them to operate each for about five minutes. Practice with the stains at these dilutions will reveal the exact times needed for the most beautiful pictures.

The most obvious advantages of the method are the simplicity of the stains used, the fact that they do not deteriorate by being kept and the great saving of time effected.

Manson's blue is readily made up and only improves by keeping. The whole staining operation does not take more than two minutes. Moreover, it is well under control, and a slight variation of the times given above may be made to produce a desired difference in the results.

THE STORY OF A TOOTH PLATE—AN UNUSUAL WAR INJURY.

By Major GORDON TAYLOR.

Royal Army Medical Corps.

Senior Assistant Surgeon to the Middlesex Hospital, etc.

During the Battle of the Somme a soldier was buried in his shelter by a large shell. He was dug out from amongst the debris in an unconscious state, and ultimately placed on a hospital barge and thus conveyed to the Base. When he recovered consciousness on the barge, one of his first requests was for the artificial tooth-plate which he had been wearing when he was rendered unconscious by the shell explosion, and which he now missed. The denture—an upper one—was produced from his wallet by the attendant orderly, but the patient, remarking its size and the number of teeth, quickly declared his doubt as to it being his, or if it were, he assured those in attendance that it must have been broken and that part of it was missing.

The patient had also shown some signs of a fracture of the skull, and to this was ascribed the difficulty in swallowing of which he complained. No radiogram was apparently taken, and he was speedily evacuated to England, and admitted into one of the Auxiliary Military Hospitals at Eastbourne. The man's story led to an investigation of the denture which showed clear evidence of having been fractured across its palatal and alveolar portions. Examination with the screen revealed the presence of a foreign body in the thorax, and an X-ray plate showed a denture with two teeth opposite the middle piece of the sternum.

I was hurriedly asked by the medical staff of the hospital to come down from London and try to remove it. The use of a Bruning's œsophagoscope fitted with a Hill's tube enabled one to obtain a good view of the offending denture, and it was easily extracted, *per vias naturales*, by means of an Irwin Moore's forceps. So far as his gullet was concerned, recovery was quite uneventful, but the original diagnosis of a fractured base of the skull was only too surely confirmed by the

development of a pulsating exophthalmos, which was successfully treated by ligature of the internal carotid artery by an able Eastbourne surgeon.

The case is of interest in that a fracture of an upper dental plate was produced without any injury of the superior maxilla. This injury is by no means unique, for I have heard of similar accidents in the present War, but the story of this particular case, where one of the fragments of the broken denture was actually swallowed by a patient rendered unconscious by the same injury that fractured the dental plate, must be almost without parallel.

Reviews.

Modern Medicine and Some Modern Remedies. By Thomas Bodley Scott. With a preface by the late Sir Lauder Brunton, Bart., F.R.S. London: H. K. Lewis and Co., Ltd. 7 × 4¾. Pp. xi and 169. 6s. net.

In daily life medicine still continues to be more of an Art than a Science, as accurate measurements are only applicable under certain limiting conditions, of which the training of the observer is not the least important. Accuracy of measurement is of course only relative; all scientific processes involve the passing of material through a series of sieves of increasing fineness of mesh, and if we are content to correlate the extent of our conclusions with the degree of coarseness of the mesh, we may still work in a truly scientific manner, and the work of the observer who is unable to apply exact methods may be of great value provided he recognizes his limitation—frames his working hypothesis accordingly and declines to extend his conclusions beyond the boundary that is justified by his method of working.

Further, the skilled observer notes, remembers, or better still, records the incommensurables, and uses this knowledge as a basis for further and more exact observation, as his method becomes more delicate and for future action where his intelligence (intuition if you will) suggests that the conditions are the same. This last—empiricism—is the art of medicine; no working hypothesis is involved beyond the postulate that things which are equal to the same thing are equal to one another.

The science of medicine has however developed so far that a third element is involved, the practical use in everyday work of the results of experimental work by trained observers, having opportunities for, and means of measurement.

This, at its best, is the same process as that by which the mechanical engineer reduces to practical working formulæ the rigid abstractions of the pure mathematician. This adjustment of experimental to practical conditions can hardly be carried out except by those who understand the principles which underlie the experimental work.

The intelligent general practitioner (the adjective would appear to be necessary) then makes use of three processes—two involving some reasoning, the third memory and the ability to recognize a previous combination.

The late Sir Lauder Brunton was a very great artist in medicine, and especially in the use of experimental work in everyday work. He was, moreover, a man of wide experience of the methods and actual work of his less distinguished brethren. His preface calls attention to the great waste of that knowledge acquired through many laborious years by the general practitioner in the course of his daily duties, a waste which has increased since the system of apprentice-

ship was discontinued. But if the general practitioner is to contribute anything of value, it can only be the result of systematic note-taking and periodic analysis and discussion of these notes; such analysis one sees only too rarely in the medical press. Sir James Mackenzie for one has shown how much can be done in the turmoil of a general practice; much of his work of course consisted of accurate measurements and deductions from them, but scattered through all his work is a mass of observation of unmeasured and immeasurable details—such as could be recorded and classified by any man in practice.

Dr. Scott's book is a very good example of what can be done by careful observation and the assimilation of the result of other men's experimental work. It is thoughtful, suggestive, delightfully written and of considerable value in the practice of the art of medicine. We need more books of this type. R. J. S. S.

Memoranda on Army General Hospitals Administration by various Authors. Edited by P. Mitchell, M.D.Aberd., Lieutenant-Colonel R.A.M.C.(T.), Commanding No. 43 General Hospital. Demy octavo, pp. vii and 109. Baillière, Tindall and Cox. 5s. net.

This is like a sheep's head, "fine confused feedin"—and full of interest—in parts. But although it cannot be considered a very important addition to one's knowledge of the subject with which it purports to deal, it contains many useful suggestions; others to which this adjective would hardly apply, as for instance that in ward dieting, "The system would be run entirely on trust as between the wards and the kitchen and the auditors would accept the sisters' summaries"; one only wishes they would.

Some of the matter deals less with a General hospital as such than with the Royal Army Medical Corps, Territorial Force.

One feels a little uncertain how far the various contributors have practical experience of at least a part of the subjects they deal with—on a good many points the reviewer would certainly not express agreement. R. J. S. S.

The Drink Problem of To-Day. Edited by T. N. Kelynack, M.D. London Methuen and Co., Ltd. 1916. $8\frac{3}{4} \times 5\frac{1}{2}$. Pp. ix and 319. 7s. 6d. net.

This is a collection of essays by various writers on the 'ologies of Alcoholism; its relation to Law, Life Assurance, Women and Children, Crime, Poverty, National Efficiency, Work, War, Legislation, the development of National Sobriety, and the means of arresting Alcoholism.

It is not a book for specialists alone, but written so that any intelligent person may read and understand. It is probably not unfair to say that the physiological, pathological, and psychological results shown in the articles dealing with these sections are not always interpreted in the sense the various authors interpret them. The statistical argument is seen well in the articles on Alcoholism and Life Assurance, but the same argument against too forcible deduction applies here as in other cases where the question of protection arises, that the total abstainer is, on the whole, probably a person who in every way takes as few risks as possible.

It does not seem at all necessary to pursue investigation into the details of the whole relations of alcoholism so far as is often done; this not only confuses, but leads to over statement and controversy. The problem can be dealt with on much simpler lines. No one can affect to be ignorant of the hideous results of excess; on the other hand, no ordinary man will ever be convinced that the moderate use of alcohol produces any ill effects whatever. The whole difficulty lies in the term moderate, which is an indefinite and indefinable expression, as the quantity varies with the individual, his work and surroundings.

Since this book was written, many things have happened which throw some light on the question. There is the legislative control of opportunity and alcoholic content; the general movement, headed by the King, to abstinence or diminution

in consumption—the latter aided by increased cost, which in this instance can hardly be called an economic factor in the ordinary sense. Again, we have the "wastage" of food-stuffs for the production of alcoholic liquors against the demand of labour for a sufficient supply. Compulsion would not appear to be successful except under strict discipline, and it certainly does not affect the desire or habit when opportunity becomes available.

The tripod on which sobriety (not abstinence) will eventually stand is formed by education, control, and the café instead of the public house.

This volume gives a very fair and useful account of the whole problem from its various aspects.

The Control of Venereal Diseases. *Edinburgh Review*. April, 1916.

This is a very clear and concise Summary—for the general reader—of the main facts of this most important matter, a summary which is sufficiently impressive in its account of the terrible consequences of infection.

To us, with experience of the benefit of control at the source, it appears that the provisions suggested for the prevention of the spread of infection after it has taken place rather suggests locking the door after the horse has been stolen. This, however, is a very complicated question, and a quotation from the last paragraph of the first article in this number of the *Review*, "The Psychology of the English," is very much to the point. "It has been possible in England to defend the worst abuses in the sacred name of the individualism that was false because it meant the freedom of some individuals to flourish at the expense of other individuals."

One is glad to find that the Press (no doubt assuming that the *jeune fille* of to-day has either something else to think about or knows all that there needs to be known) has opened its columns to the public discussion of a matter which is at least as important as the arrest of tnberculosis. We probably have less of the Pharisee than we had "before the War," and with the increasing open influence of women, we may arrive at some mode of combating this scourge.

A Graphic Record of the Work of a Gonorrhœa Division. By Captain A. M. Davidson, R.A.M.C. (T.C.).

If one were asked what was likely to be the state of a section of a V. D. Hospital, in which 400 patients were under the care of one medical officer, three N.C.O.'s, and about three men, one would have no hesitation in answering "chaos," and be right in the majority of instances. A graphic record, which has been produced by Capt. A. M. Davidson, of the work of his division under the above conditions proves, however, that chaos is not by any means necessary. On the contrary, it is not only possible to carry out systematic treatment, but to compile records relating to gonorrhœa and its management, which are of the greatest value. The secret lies in the intelligent use of patients, as demonstrated in this record, which is a bound, type-written volume, dealing with details of administration in gonorrhœa, housing of patients, plans of treatment and their results, and numerous matters of clinical and statistical interest, illustrated by many photographs, paintings, plans, and charts. The book has been placed in the Royal Army Medical Corps Library, and should be consulted by all those interested in the organization of venereal treatment.

To mention a few of the main features of this work, the first chapter deals with accommodation of the patients in the section, and in housing of the treatment facilities. This is illustrated by a plan of the division, sketches and photographs of the treatment hut and acute-case tents, and a plan and elevation of a hip-bath house erected by the patients. Chapter II deals with establishment and its duties, the latter being set out in detail for each person concerned. The detail of the establishment is as mentioned in the paragraph above. Chapter III is

devoted to details of administration, such as admission of patients, bathing, disinfection of kit, etc., and procedure on discharge of a patient from hospital. Medical inspection of new admissions is dealt with in Chapter IV, which is illustrated by photos and paintings of interesting clinical conditions. Chapter V is devoted to the details of the irrigation treatment of gonorrhœa, and is illustrated by sketches of an irrigation trough (with dimensions), arrangement of an irrigation pail, showing height from the ground, an arrangement of the syphon, a standard colour of 1/8,000 permanganate, etc. Chapters VI and VII deal with the treatment by vaccine and by intramuscular injections of succinimide of mercury. The author's opinion is that neither of these is of any value, and he cites in support of his opinion a number of detailed statistics to be found in the appendix. The reviewer's criticism of these is that they relate to cases which were by no means under parallel conditions: the latter varied, in fact, so widely that considering the slight differences in the results, the various series are of no value for the institution of a comparison between any one treatment and another. The remaining chapters are devoted to the complications of gonorrhœa and their treatment, and are profusely illustrated. The appendix is occupied by numerous statistical tables and charts, and a chapter by Private L. Hulls, the laboratory chemist, on the chemistry of the mercurial compounds, which have been used in this hospital for the treatment of gonorrhœa. There is also an account of an experiment on a rather large scale to determine the value of purely medicinal as opposed to medicinal and local treatment of gonorrhœa. The experiment was carried out on 200 patients, and was abandoned after two months, when it became obvious that the purely medicinal treatment was a complete failure as compared with the irrigation treatment. The more serious sections of the book are relieved by the illustrations at its beginning and end, which must be seen to be appreciated.

The work, which was typed and largely illustrated by his patients, is a monument to the industry and powers of organization of its author.

Correspondence.

CIGARETTE SMOKING AND "NERVES."

TO THE EDITOR OF THE "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS."

SIR,—I was glad to see recent letters in the daily papers dealing with "nerves" due to too much tobacco.

It is not exaggerating to say that there are at the present moment thousands of officers and men in hospitals, convalescent hospitals, command depots and home battalions who are delaying their cure and preventing themselves from becoming fit for active service by excessive cigarette smoking.

I have been for twelve months on a travelling medical board examining on an average 1,000 men per week, and for five months I was inspector of civil hospitals and convalescent auxiliary hospitals in a large centre, so I am writing about what I know.

If anyone wishes to roughly test the truth of my assertion, let him look at the hands of the next ten patients he meets who have been a long time in hospital and who complain of nerves; he will find that their first and second fingers are stained dark brown with nicotine. This is the "outward and visible sign" of the excessive cigarette smoker.

The difficulty of dealing with the matter lies in the fact that smoking in moderation is not injurious to the majority of men who are in good health, and it is extremely agreeable; but in the interests of the country some vigorous action ought undoubtedly to be taken to discourage smoking by immature recruits, and by patients suffering from any form of heart trouble, general debility or nervousness —to these nicotine is poison. Medical men are well aware of this, but do not like to take a firm stand against the evil because it would make them unpopular.

What trainer would allow his pupils to smoke cigarettes, whether he was training them for boxing, football, racing or other form of contest necessitating a sound heart and good wind? Yet soldiers are not alone allowed, but encouraged by well meaning associations and people who are continually supplying them with these aids to inefficiency either free or at a small cost.

To discourage smoking, I would suggest that a notice to the following effect should be posted up in every ward in all our hospitals, convalescent homes, command depots, and medical inspection rooms.

NOTICE.

When a man is not in perfect health smoking produces disorderly action of the heart and tends to make him nervous and shaky. It spoils his shooting and his wind, and he does not feel fit and vigorous.

For these reasons in their own interests, and in order to hasten their cure, men who are suffering from any form of heart trouble, general debility, or nervousness are forbidden to smoke.

BY ORDER.

A notice to this effect is being posted in every medical inspection room and in every ward in all military hospitals in the South of Ireland. I believe that the educational effect would be excellent, and that medical officers' hands would be strengthened in dealing with cases injuring themselves by too much smoking should the necessary authority be obtained for having these notices printed and posted in all British hospitals and medical inspection rooms.

The subject is certainly one for serious consideration as the quality of our man power is as important as the quantity.

I am, etc.,

G. J. Stoney Archer, *Lieutenant-Colonel R.A.M.C.*,
February 9, 1918. *A.D.M.S., Cork District.*

JOURNAL

OF THE

ROYAL ARMY MEDICAL CORPS.

Corps News.

FEBRUARY, 1918.

EXTRACTS FROM THE LONDON GAZETTE.

War Office,
January 14, 1918.

The following Russian Decorations and Medals have been awarded at various dates for Distinguished Services rendered during the course of the campaign :—

His Majesty the King has given unrestricted permission in all cases to wear the Decorations and Medals in question.

ORDER OF ST. ANNE, 2ND CLASS (WITH SWORDS).

Lieut.-Col. (Acting Col.) Henry Hewetson, D.S.O., Royal Army Medical Corps.

ORDER OF ST. ANNE, 3RD CLASS.

Temp. Capt. Arthur Herbert Spicer, M.B., Royal Army Medical Corps.

ORDER OF ST. STANISLAS, 2ND CLASS.

Lieut.-Col. Wilfred William Ogilvy Beveridge, C.B., D.S.O., M.B., Royal Army Medical Corps.
Temp. Major Lanyon Edward Owen, Royal Army Medical Corps.

ORDER OF ST. STANISLAS, 3RD CLASS (WITH SWORDS).

Lieut. (Temp. Capt.) Thomas James Kelly, M.C., M.B., Royal Army Medical Corps.

ORDER OF ST STANISLAS, 1ST CLASS.

Surg.-Gen. John Dallas Edge, C.B., M.D., F.R.C.S.

ORDER OF ST. STANISLAS, 3RD CLASS (WITH SWORDS).

Hon. Capt. John Herbert Diamond, Canadian Army Medical Corps.
Capt. Charles Allen Yates, Canadian Army Medical Corps.

His Majesty the King has been graciously pleased to approve of the award of a Bar to the Military Medal to the undermentioned Non-Commissioned Officers and Man :—

No. 341509 (formerly No. 1916) Serjt. B. Jones, Royal Army Medical Corps (Wrexham). (M.M. gazetted July 9, 1917.)

No. 339198 (formerly No. 1563) Serjt. S. J. Kay, Royal Army Medical Corps (Liverpool). (M.M. gazetted July 18, 1917.)

No. 341364 (formerly No. 1754), Serjt. A. Stephenson, Royal Army Medical Corps (Wigan). (M.M. gazetted August 16, 1917.)

No. 341628 (formerly No. 2053) Pte. P. Harrison, Royal Army Medical Corps (St. Helens). (M.M. gazetted November 2, 1917.)

His Majesty the King has been graciously pleased to approve of the award of the Military Medal for Bravery in the Field to the undermentioned Non-Commissioned Officers and Men :—

ROYAL ARMY MEDICAL CORPS.

No. 90800 Pte. F. C. Alder (Birmingham).
No. 301452 Pte. C. S. Auld (Mersat).
No. 341025 Pte. G. Barron (Thatto Heath).
No. 60326 Pte. F. Beasley (Birmingham).
No. 339463 Pte. J. H. Binedell (Capetown).
No. 339377 Pte. W. M. Bishop (Liverpool).
No. 50308 Pte. R. Slyth (Dundee).
No. 50290 Pte. R. A. Bouckley (Birmingham).
No. 352126 Pte. E. Brownwood (Burnley).
No. 49980 Pte. G. A. Burnage (Stanley).
No. 497601 Lance-Cpl. (Acting Cpl.) S. A. Callaway (Slough).

No. 41517 Pte. D. Challenor (Achddw).
No. 36309 Pte. (Acting Lance-Cpl.) J. Clarke (Lochgelly).
No. 106906 Pte. E. D. Collins (Middlesbrough).
No. 72169 Pte. W. C. Daniels (Chelmsford).
No. 65867 Pte. H. Everall (Malvern Link).
No. 50236 Staff-Serjt. H. Fisher (Abbots Langley).
No. 354246 Serjt. A. H. Fox (Stockport).
No. 69659 Pte. T. H. Francis (Greenwich).
No. 36505 Serjt. J. V. Green (Handsworth).
No. 72773 Pte. O. Harewell (Harroden).
No. 77444 Pte. F. Hodgson (York).
No. 72003 Pte. F. Hodson (Burton Latimer).
No. 47018 Pte. N. Hough (Alderney).
No. 341318 Serjt. T. R. Jackson (St. Helens).
No. 301352 Cpl. A. Livingstone (Dundee).
No. 354337 Serjt. J. Lomax (Eccles).
No. 341178 Cpl. J. McDermott (St. Helens).
No. 93945 Serjt. P. J. Mitchelson (Glasgow).
No. 303297 Pte. A. Morrison (Aberdeen).
No. 12298 Pte. S. G. Phillips (Kingswinford).
No. 352205 Pte. (Acting Lance-Cpl.) H. D. Preston (Burnley).
No. 30997 Serjt. P. T. Read (Bournemouth).
No. 368097 Pte. P. I. Rees (Garnant).
No. 341576 Lance-Cpl. T. Sherlock (Blackpool).
No. 473007 Serjt. A. G. Shrubb (Ipswich).
No. 47207 Cpl. (Acting Serjt.) G. Sim (Bridge of Allan).
No. 341771 Pte. T. Singleton (Carlisle).
No. 53779 Pte. J. Stephen (Mill of Auchintoul).
No. 337597 Pte. E. R. Stuckey (Cardiff).
No. 337634 Pte. S. W. Stuckey (Cardiff).
No. 337211 Serjt. J. Tickle (Formby).
No. 33384 Pte. A. Turner (Bristol).
No. 475351 Pte. R. H. Watson (Cambridge).

His Majesty the King has been graciously pleased to approve of the award of the Meritorious Service Medal to the undermentioned Non-commissioned Officers and Man in recognition of valuable services rendered in the performance of Military duty :—

No. 18604 Staff Serjt. W. Tindall, Royal Army Medical Corps (Bradford).
No. 2091 Pte. (Acting Cpl.) T. W. Elwood, Royal Army Medical Corps (Sheffield).
No. 178 Serjt. A. E. Wilkinson, Royal Army Medical Corps (Caterham).

War Office,
January 28, 1918.

The following are among the Decorations and Medals awarded by the Allied Powers at various dates to the British Forces for Distinguished Services rendered during the course of the campaign.

His Majesty the King has given unrestricted permission in all cases to wear the Decorations and Medals in question.

DECORATIONS AND MEDALS CONFERRED BY H.M. THE KING OF SERBIA.

Order of St. Sava, 2nd Class.

Surgeon-General Sir Hayward Reader Whitehead, K.C.B., Director of Medical Services, British Salonika Force.

Order of St. Sava, 3rd Class.

Lieut.-Col. Francis John Brakenridge, C.M.G., Royal Army Medical Corps.
Lieut.-Col. Herbert John Martin Buist, D.S.O., M.B., Royal Army Medical Corps.
Col. Stephen Frazer Clark, M.B., late Royal Army Medical Corps.
Temp. Col. Thomas Crisp English, C.M.G., M.B., F.R.C.S., Army Medical Service.
Lieut.-Col. Bernard Forde, C.M.G., M.B., Royal Army Medical Corps.
Lieut.-Col. Archibald Gilchrist Hay, M.D., Royal Army Medical Corps.
Temp. Col. James Purves Stewart, C.B., M.D., F.R.C.P., Army Medical Service.
Col. Alexander Arthur Sutton, C.B., D.S.O., Royal Army Medical Corps.

Order of St. Sava, 4th Class.

Capt. Alfred Edward Barnes, M.B., Royal Army Medical Corps.
Capt. Edward John Yelverton Brash, Royal Army Medical Corps.
Brevet Major Daniel Maurice Corbett, M.B., Royal Army Medical Corps.
Capt. Harold William Farebrother, Royal Army Medical Corps.
Temp. Capt. Richard Desmond Fitzgerald, M.B., Royal Army Medical Corps.
Temp. Capt. Charles York Flewitt, M.B., Royal Army Medical Corps.
Capt. William Rickards Galwey, M.C., M.B., Royal Army Medical Corps.
Temp. Capt. Arthur Atkins Greenwood, M.B., Royal Army Medical Corps.
Capt. Archibald Wilson Harrington, M.D., Royal Army Medical Corps.
Temp. Capt. Walter Haward, M.B., Royal Army Medical Corps.
Major John Tyrer Johnson, D.S.O., M.D., Royal Army Medical Corps.
Temp. Major James Benjamin Melville, Army Medical Service.
Temp. Major George Percival Mills, M.B., Royal Army Medical Corps.
Temp. Major Keith Waldegrave Monsarratt, M.B., F.R.C.S., Royal Army Medical Corps.
Capt. William Lombard Murphy, Royal Army Medical Corps.
Temp. Major Leonard Gregory Parsons, Royal Army Medical Corps.
Major Henry Rutherford, M.D., Royal Army Medical Corps.

Capt. Richard Vincent Slattery, Royal Army Medical Corps.
Temp. Capt. Clare Oswald Stallybrass, Royal Army Medical Corps.
Major Frederick Archer Stephens, D.S.O., Royal Army Medical Corps.
Major Walter John Weston, D.S.O., Royal Army Medical Corps.
Harold Waterlow Wiltshire, Esq., M.D., Royal Army Medical Corps.
Temp. Capt. Lionel Dudley Woods, Royal Army Medical Corps.

Order of St. Sava, 5th Class.

Temp. Qmr. and Hon. Lieut. Hubert James Angell, Royal Army Medical Corps.
Temp. Qmr. and Hon. Lieut. John Fraser, Royal Army Medical Corps.
Temp. Lieut. John Norman McTurk, M.D., Royal Army Medical Corps.
Temp. Qmr. and Hon. Lieut. Frederick William Sharpe, Royal Army Medical Corps.
Temp. Qmr. and Hon. Major Harry Humphreys Taylor, M.B., Royal Army Medical Corps.
Temp. Lieut. Harold Cairns Terry, Royal Army Medical Corps.
Temp. Lieut. John Henry Watson, Royal Army Medical Corps.

Order of St. Sava, 3rd Class.

Major (Temp. Lieut.-Col.) Alexander Edward Kidd, M.B., Royal Army Medical Corps.

Order of St. Sava, 4th Class.

Temp. Capt. Frederick Michael Bishop, Royal Army Medical Corps.
Capt. Bernard Langridge Davis, Royal Army Medical Corps.
Capt. James Fenton, M.D., Royal Army Medical Corps.
Capt. Robert Fullarton, M.B., Royal Army Medical Corps.
Temp. Lieut. Bernard Whitchurch Howell, M.B., F.R.C.S., Royal Army Medical Corps.
Capt. Alexander Brown Jamieson, M.B., Royal Army Medical Corps.
Capt. Philip Henry Mitchiner, M.B., F.R.C.S., Royal Army Medical Corps.
Capt. Alexander Reid Moodie, M.B., Royal Army Medical Corps.
Capt. William Arthur Valentine, M.D., Royal Army Medical Corps.
Major Hugh Walker, M.B., Royal Army Medical Corps.

Order of St. Sava, 5th Class.

Captain Harry James Shields, Canadian Army Medical Corps.

His Majesty the King has been graciously pleased to approve of the award of the Military Medal for Bravery in the Field to the undermentioned Non-commissioned Officers and Men :—

ROYAL ARMY MEDICAL CORPS.

No. 3877 Pte. W. Bonner (Londonderry).
No. 403111 Pte. R. Bottomley (Leeds).
No. 65289 Pte. S. F. Bourne (Canterbury).
No. 77190 Pte. C. Bouttell (Hackney).
No. 405247 Cpl. H. Bower (Sheffield).
No. 8691 Pte. F. H. Boyer (Newton Abbot).
No. 62486 Pte. W. Boys (Liverpool).
No. 106232 Pte. A. A. Brawn (Wellingborough).
No. 36765 Cpl. (Acting Serjt.) S. Bristow (Atherstone).
No. 8252 Pte. A. Buckley (Shaw).
No. 58336 Pte. (Acting Lance-Cpl.) J. Burbidge (Doncaster).
No. 32055 Pte. C. Burton (West Hartlepool).
No. 78402 Pte. H. Burton (Hunslet).
No. 437253 Pte. W. Church (Birmingham).
No. 439199 Pte. F. G. Clark (Bristol).
No. 31164 Pte. W. Cliff (Barnsley).
No. 80759 Pte. M. F. Cooper (Ramsgate).
No. 403564 Lance-Cpl. R. J. Cooper (Leeds).
No. 33115 Cpl. R. Christie (Glasgow).
No. 4709 Pte. R. J. E. Crosland (Todmorden).
No. 45038 Pte. H. Doherty (Bolton).
No. 3108 Pte. J. Donnelly (Arklow).
No. 29253 Pte. F. Entwistle (Oswaldwistle).
No. 437062 Pte. S. Fearn (Birmingham).
No. 37520 Pte. C. F. Field (Horsham).
No. 72622 Pte. H. S. Foster (Wood Green).
No. 76732 Pte. W. L. Francis (Woodford).
No. 70982 Pte. F. Frank (Hull).
No. 459302 Lance-Cpl. H. A. French (Ashburton).
No. 4700 Cpl. (Acting Serjt.) F. Gardner (W. Kensington).
No. 461344 Cpl. C. R. Garrett (Eastleigh).
No. 65300 Pte. C. E. Golden (Homefield).
No. 5862 Cpl. (Acting Serjt.) G. T. Gwilt (Wolverhampton).
No. 10368 Pte. A. Halliwell (Ince).
No. 9263 Pte. F. Hawley (Derby).
No. 46783 Pte. E. Haynes (Hunsley).
No. 277 Pte. H. H. Haynes (Godalming).
No. 3984 Pte. T. Henderson (Dundee).
No. 34989 Serjt. H. E. Hogg (Croydon).
No. 5800 Pte. (Acting Lance-Cpl.) F. J. Hollier (Bristol).
No. 37483 Pte. H. C. M. Hooper (Darlington).
No. 667 Pte. G. Jarvis (Worcester).
No. 77644 Pte. W. S. Jenkins (Brixton).
No. 5810 Pte. V. Keily (Stradbally).
No. 439131 Cpl. F. G. Lodge (Bristol).
No. 1108 Pte. J. Marner (Dunadry).
No. 83339 Pte. W. F. Marshall (Bradford).
No. 47673 Pte. A. W. Martin (Bosham).
No. 9258 Pte. C. A. Martin (Derby).
No. 457155 Cpl. T. H. Matthews (Exeter).
No. 3135 Pte. (Acting Serjt.) H. McDonald (Glasgow).
No. 43044 Pte. R. McLean (Lochgelly).
No. 7720 Pte. W. McQueen (Edinburgh).
No. 69252 Pte. W. G. Millington (Shrewsbury).
No. 88173 Pte. G. D. Morrison (Aberdeen).
No. 61185 Pte. A. Mountford (Bashford).
No. 19675 Serjt. C. Newland (Wrexham).

No. 65756 Pte. A. E. Payne (Dover).
No. 92216 Pte. A. C. Pook (Plymouth).
No. 437359 Lance-Cpl. C. Pratt (Birmingham).
No. 54483 Serjt. W. Price (Brookend).
No. 435169 Pte. W. Raybould (Aston).
No. 36040 Pte. (Acting Cpl.) C. J. Rogers (Abbots Langley).
No. 32464 Pte. J. G. Sandbrook (Stockton-on-Tees).
No. 57998 Pte. D. Scutt (Portslade).
No. 74579 Pte. G. W. Seal (Berkhamsted).
No. 5736 Pte. (Acting Cpl.) C. Sebry (Walworth).
No. 58419 Pte. J. Sergent (Blackpool).
No. 435443 Pte. G. Shakeshaft (Wellington).
No. 89132 Pte. S. Shepherd (Dunstan-on-Tyne).
No. 54711 Pte. (Acting Lance-Cpl.) S. Sloan (Hamolton).
No. 19815 Corpl. (Acting Serjt.) A. Smith (Harwich).
No. 33354 Pte. A. E. Smith (Halifax).
No. 9035 Pte. H. Stallard (Port Sunlight).
No. 74593 Pte. S. J. Staniford (Berkhamstead).
No. 45798 Pte. J. G. Stormont (Sunderland).
No. 3524 Pte. (Acting Lance-Corpl.) R. A. Swales (York).
No. 53089 Pte. D. Thomson (Dundee).
No. 403550 Lance-Corpl. H. H. Turner (Morley).
No. 33591 Pte. C. Viney (Stanford).
No. 20458 Pte. R. Ward (Dereham).
No. 403067 Serjt. E. Wilkinson (New Wortley).
No. 7079 Pte. (Acting Serjt.) J. F. Williams (Newton Abbot).

War Office,
February 4, 1918.

His Majesty the King has been pleased to confer the undermentioned rewards for Gallantry and Distinguished Service in the Field. The acts of gallantry for which the decorations have been awarded will be announced in the *London Gazette* as early as possible :—

AWARDED A BAR TO THE DISTINGUISHED SERVICE ORDER.

Major (Temp. Lieut.-Col.) Arthur Carr Osburn, D.S.O., Royal Army Medical Corps (D.S.O. gazetted June 3, 1916).

AWARDED THE DISINGUISHED SERVICE ORDER.

Temp. Capt. Ferguson Fitton Carr-Harris, M.D., Royal Army Medical Corps.

Major (Temp. Lieut.-Col.) Charles Arthur Algernon Stidson, M.D., Royal Army Medical Corps.

AWARDED A BAR TO THE MILITARY CROSS.

Capt. Cuthbert Delaval Shafto Agassiz, M.C., M.D., Royal Army Medical Corps.

Temp. Capt. Arthur Joseph Blake, M.C., Royal Army Medical Corps (M.C. gazetted September 22, 1916).

Capt. Eric Alfred Charles Fazan, M.C., Royal Army Medical Corps (M.C. gazetted January 14, 1916).

Temp. Capt. James Wallace Macfarlane, M.C., M.D., Royal Army Medical Corps.

Capt. Samuel McCausland, M.C., Royal Army Medical Corps (M.C. gazetted July 26, 1917).

Capt. Joseph Stephen Wallace, M.C., Royal Army Medical Corps (M.C. gazetted July 26, 1917).

AWARDED THE MILITARY CROSS.

Royal Army Medical Corps.

Capt. Robert Vacy Clifford Ash.
Capt. Arthur Joseph Beveridge, M.B., Special Reserve.
Capt. John Holiday Blackburn, M.B.
Temp. Capt. Joseph Victor Cope, M.B.
Temp. Capt. David McMurray Dickson.
Capt. (Temp. Major) John Douglas Fiddes.
Capt. John Henry Pearson Fraser, M.B.
Capt. Philip Jacob Gaffibin, M.B., Special Reserve.
Temp. Capt. Hugh Bernard German.
Temp. Capt. Frank Arthur Grange, M.B.
Temp. Capt. Edwin Allan Thomas Green.
Temp. Lieut. Arthur Collis Hallowes, M.B.
Temp. Capt. James Phillips Jones.
Temp. Capt. Frederick Bennett Julian, M.B.
Temp. Capt. Arthur Griffiths Maitland-Jones.
Lieut. (Temp. Capt.) William Wyllie MacNaught, M.B.
Temp. Capt. James Manuel, M.B.
Lieut. John Marshall, M.B., Special Reserve.
Temp. Capt. Duncan John McAfee, M.D.
Temp. Capt. Frederick Buick McCarter, M.B.
Temp. Capt. James Allen Montgomery, M.D.
Capt. George Morris, M.B., Special Reserve.
Temp. Lieut. David Assur Henry Moses.
Temp. Lieut. Evan Edward Owens.
Capt. Harold Dobson Pickles, M.B.
Capt. John Alexander Pridham, Special Reserve.
Capt. William Robertson, M.B.
Temp. Capt. Lionel Matthew Rowlette, D.S.O.
Temp. Capt. Cedric Russell, M.B.
Temp. Capt. Robert Rutherford, M.B.
Temp. Capt. Brian Herbert Swift, M.B.
Capt. Arthur Peregrine Thomson.
Temp. Capt. George Dibbs King Waldron, M.B.
Capt. Douglas Larmer Wall, M.B.
Capt. James Anderson Young, M.D., Special Reserve.
Capt. James Carruthers Young, M.D., Special Reserve.
No. 32610 S. M. Frank Hulbert.

Lieut. S. Dutt, Indian Medical Service.

Canadian Force.

Army Medical Corps.

Capt. Edgar Douglas.
Capt. Austin Dwight Irvine.
Capt. Gordon Leigh Jepson.
Capt. James Grant MacNeill.
Capt. Wesley Herbert Secord.
Capt. William Ewing Sinclair.

New Zealand Force.

Capt. Rex Carrington Brewster, F.R.C.S., Medical Corps.

His Majesty the King has been graciously pleased to approve the award of a Bar to the Military Medal to the undermentioned Non-commissioned Officers and Man:—

No. 386062 Serjt. J. Malia, Royal Army Medical Corps (Newcastle-on-Tyne) (M.M. gazetted October 27, 1916).

No. 19306 Corpl. (Acting Serjt.) C. Speller, Royal Army Medical Corps (Nutana, Canada).

No. 1485 Pte. J. Tipping, Royal Army Medical Corps (Belfast) (M.M. gazetted March 12, 1917).

No. 1407 Cpl. (Acting Serjt.) G. Staples, Royal Army Medical Corps (Tulse Hill) (M.M. gazetted July 9, 1917).

His Majesty the King has been graciously pleased to approve of the award of the Military Medal for Bravery in the Field to the undermentioned Non-commissioned Officers and Men:—

ROYAL ARMY MEDICAL CORPS.

No. 54771 Pte. (Acting Serjt.) J. Anderson (Hirst Ashington).
No. 59053 Pte. W. Armstrong (Norwich).
No. 495466 Pte. W. J. Bailey (Easton).
No. 497272 Lance-Cpl. C. F. Bicknell (Tolworth, Surrey).
No. 497518 Pte. W. J. Brickwood (Horsham).
No. 63901 Pte. B. G. Brown (Lower Edmonton).
No. 18814 Pte. R. Butcher (Crawley).
No. 63856 Pte. J. Carroll (Old Cummock),
No. 459473 Serjt. H. S. Cliff (Torquay).
No. 51587 Pte. W. Collier (Bolton).
No. 35664 Cpl. (Acting Serjt.) R. Davies (Putson).
No. 341734 Pte. G. Farrimond (St. Helens).
No. 1418 Pte. G. J. Gentry (Tooting, S.W.).
No. 68193 Cpl. T. Geraghty (Dublin).
No. 105765 N. W. Green (Littletown, Yorks).
No. 90561 Pte. H. B. Griffiths (Shrewsbury).
No. 4976 Cpl. W. W. C. Hall (Liverpool).
No. 5064 Pte. (Acting Lance-Cpl.) T. Horrocks (Liverpool).
No. 497593 Pte. E. Howe (Richmond).
No. 534233 Serjt. H. Hubbard (West Croydon).
No. 48795 Pte. A. L. Jones (Ferndale).
No. 495380 Serjt. A. Kimberley (Slough).
No. 493620 Pte. W. C. Madley (Barnsbury, N.).
No. 493441 Serjt. R. N. Marchant (Sevenoaks).
No. 68092 Pte. H. McCann (Smithone Croy, by Glasgow).
No. 51934 Pte. M. Meehan (Ferryhill).
No. 43277 Pte. W. Mellor (Oldham).
No. 305315 Pte. D. M. Meston (Roslyn, Midlothian).
No. 495412 Serjt. W. A. Nowers (Canterbury).
No. 350191 Lance-Serjt. E. E. Parry (Chorlton-on-Medlock).
No. 32959 Pte. R. Plumridge (High Wycombe).
No. 63643 Pte. T. S. Purcell (New York).
No. 73610 Pte. H. E. Rushton (Ashbourne).
No. 493628 Pte. H. J. Sanders (Kettering).
No. 318411 Pte. W. Scott (Selkirk).
No. 417343 Pte. W. Shannon (Derby).
No. 5289 Pte. F. Sims (East Huddersfield).
No. 40609 Pte. H. Spence (Oldham).
No. 78828 Pte. H. C. Stables (Halifax).
No. 69931 Pte. T. Stafford (Newcastle-on-Tyne).
No. 90053 Cpl. F. J. Stevens (Margate).
No. 63872 Pte. (Acting Lance-Cpl.) T. Taaffe (Louth, co. Louth).
No. 386046 Pte. J. Tearce (Newcastle-on-Tyne).
No. 497309 Serjt. A. A. Weaver (Kew Gardens).
No. 30399 Pte. G. Wilmot (Cullompton).
No. 74694 Pte. F. A. Wyllyams (Bristol).

CHANCERY OF THE ORDER OF SAINT MICHAEL AND SAINT GEORGE.

Downing Street,
February 7, 1918.

The King has been graciously please to give directions for the following appointments to the Most Distinguished Order of Saint Michael and Saint George for services rendered in connexion with Military Operations in Mesopotamia, To be dated January 1, 1918.

To be Additional Members of the Third Class or Companions of the said Most Distinguished Order:—

Col. (Temp. Surg.-Gen.) Alfred Percy Blenkinsop, C.B., Army Medical Service.

War Office,
February 7, 1918.

His Majesty the King has been graciously pleased to approve of the undermentioned rewards for Distinguished Services rendered in connexion with Military Operations in Mesopotamia, dated January 1, 1918.

TO BE BREVET LIEUTENANT-COLONEL.

(On Retired List, Reserve of Officers, Special Reserve, New Army or Territorial Force, in the case of Officers belonging to these categories, as applicable.)

Major (Temp. Lieut.-Col.) W. H. Hamilton, D.S.O., F.R.C.S., Indian Medical Service.
Major (Acting Lieut.-Col.) J. C. H. Leicester, M.D., F.R.C.S., Indian Medical Service.
Major W. H. Leonard, F.R.C.S., Indian Medical Service.

To be Brevet Major.

(On Retired List, Reserve of Officers, Special Reserve, New Army or Territorial Force, in the case of Officers belonging to these categories, as applicable.)
Capt. G. G. James, M.B., Indian Medical Service.
Capt. J. A. S. Phillips, Indian Medical Service.

Awarded the Distinguished Service Order.

Major (Temp. Lieut.-Col.) Robert Macpherson Barron, Indian Medical Service.
Major (Temp. Lieut.-Col.) Frank Powell Connor, F.R.C.S., Indian Medical Service.
Major (Acting Lieut.-Col.) Charles Aikman Gourlay, M.D., Indian Medical Service.
Lieut.-Col. Thomas Bernard Kelly, F.R.C.S., Indian Medical Service.
Major Edmund Arthur Roberts, Indian Medical Service.
Major (Assistant Lieut.-Col.) Joseph Francis Whelan, M.D., Royal Army Medical Corps.

Awarded the Military Cross.

Capt. Hargobind Lal Batra, Indian Medical Service.
Temp. Capt. Robert Campbell Bogg, M.B., Royal Army Medical Corps.
Capt. John Williamson Dalglish, M.B., Royal Army Medical Corps (Special Reserve).
Capt. Monindranath Das, M.B., Indian Medical Service.
Temp. Capt. Richard Denis Davy, M.B., Royal Army Medical Corps.
Capt. Paul Knighton Gilroy, M.B., Indian Medical Service
Temp. Capt. Robert Hamer Hodges, Royal Army Medical Corps.
Lieut. William Peat Hogg, Indian Medical Service.
Temp. Capt. William Edward Hopkins, M.B., F.R.C.S., Royal Army Medical Corps.
Capt. John Wilson Maclean, M.B., Royal Army Medical Corps (Special Reserve).
Temp. Capt. Robert Yelverton Stones, M.B., F.R.C.S.E., Royal Army Medical Corps.

Amendments.

The following are the correct descriptions of Officers and other ranks whose rewards were published in the *London Gazette*, dated January 1, 1918.

Page 6, Col. Rupert Major Downs, Australian Army Medical Corps. (C.M.G. awarded.)
Page 6, Col. Arthur Thomas White, Australian Army Medical Corps. (C.M.G. awarded.)

Awarded Distinguished Service Order.

Page 24, Major George Waterston Miller, Royal Army Medical Corps.
Page 27, Major Alan Sinclair Darvell Barton, Australian Army Medical Corps.
Page 28, Lieut.-Col. Charles Ernest Wassell, Australian Army Medical Corps.

Awarded the Military Cross.

Page 42, Qmr. and Hon. Capt. John Hannaford Maunder, Royal Army Medical Corps.
Page 53, delete Capt. Richard Todd Wilson Herald, Canadian Army Medical Corps. The award of the Military Cross to this officer is shown on page 52.

War Office,
February 18, 1918.

His Majesty the King has been pleased to confer the undermentioned rewards for Gallantry and Distinguished Service in the Field. The acts of gallantry for which the decorations have been awarded will be announced in the *London Gazette* as early as practicable :—

Awarded a Second Bar to Military Cross.

Temp. Capt. Archibald Fullerton, M.C., M.B., Royal Army Medical Corps (M.C. gazetted January 1, 1917, Bar to M.C. gazetted October 18, 1917).
Capt. William Fotheringham, M.C., M.D., Royal Army Medical Corps, Special Reserve (M.C. gazetted August 16, 1917).
Temp. Capt. William John Knight, M.C., M.D., Royal Army Medical Corps (M.C. gazetted May 31, 1916).
Capt. Thomas Ainsworth Townsend, M.C., Royal Army Medical Corps (M.C. gazetted November 25, 1916).

Canadian Force.

Capt. Frederick William Lees, M.C., Army Medical Corps (M.C. gazetted January 1, 1917).

Awarded the Military Cross.

Temp. Capt. Eric Phillip Blashki, M.B., Royal Army Medical Corps.
Capt. Frank Chadwick, M.B., Royal Army Medical Corps.
Temp. Capt. Thomas Maitland Crawford, M.B., Royal Army Medical Corps
Temp. Capt. William Claughton Douglass, Royal Army Medical Corps.

Temp. Lieut. Frederick Barnes Elwood, Royal Army Medical Corps.
Capt. Archibald McLaren Ferrie, M.B., Royal Army Medical Corps, Special Reserve.
4th Class Assistant Surgeon James Garnett Goodman, I.S.M.D.
Temp. Capt. James Huntly Legge, M.B., Royal Army Medical Corps.
Capt. Reginald Devereux Moore, Royal Army Medical Corps.
Capt. John Gilbert Morgan, Royal Army Medical Corps.
Temp. Capt. John Oscar Thomas, Royal Army Medical Corps.
Temp. Capt. Philip Hewer Wells, Royal Army Medical Corps.
Temp. Capt. Ernest William Gilmore Young, M.B., Royal Army Medical Corps.
Capt. Gavin Young, M.B., Royal Army Medical Corps, Special Reserve.

Canadian Force.

Capt. George May Foster, Army Medical Corps.
Capt. Alfred Stannage Porter, Army Medical Corps.

His Majesty the King has been pleased to award the Distinguished Conduct Medal to the undermentioned for Gallantry and Distinguished Service in the Field :–

No. 492032 Serjt. J. Easton, Royal Army Medical Corps (Margate).

For conspicuous gallantry and devotion to duty. The ambulance was shelled, and he was wounded in several places, but he remained at duty and continued to attend to the wounded under fire. He set a splendid example to all.

No. 39741 Pte. J. Gallimore, Royal Army Medical Corps (Tyldesley).

For conspicuous gallantry and devotion to duty. He showed great courage and self-sacrifice in attending to the wounded under heavy fire.

No. 362050 Qmr.-Serjt. (Acting Serjt.-Major) J. E. Pritchard, Royal Army Medical Corps (Chester).

For conspicuous gallantry and devotion to duty. He rendered valuable service in connexion with the formation of an amalgamated field ambulance, the success of which was largely due to his good work.

No. 368311 Pte. W. W. Ward, Royal Army Medical Corps (Swansea).

For conspicuous gallantry and devotion to duty. When orders were given for the advanced dressing station to withdraw, there was not sufficient transport available to remove all the casualties. He was left with six severely wounded cases, but with great initiative and skill he extemporized means for getting them away, and succeeded in removing them all to safety and preventing their capture by the enemy.

No. 851 1st Class Sub-Assistant Surgeon Bhagwan Singh, I.S.M.D., gazetted June 26, 1916

No. 1115 1st Class Sub-Assistant Surgeon Ishar Singh, I.S.M.D., gazetted June 26, 1916.

War Office,
February 12, 1918.

The undermentioned Officers have been brought to the notice of the Secretary of State for War, by the Army Council, for very valuable services rendered in connexion with the war up to December 31, 1917 :—

Lieut.-Col. H. S. Anderson, Royal Army Medical Corps.
Temp. Lieut.-Col. A. Balfour, C.M.G., M.D., F.R.C.P., Royal Army Medical Corps.
Temp. Col. C. A. Ballance, C.B., M.V.O., M.B., F.R.C.S., Army Medical Service.
Surg.-Gen. Sir D. Bruce, Knt., C.B., F.R.S., F.R.C.P., M.B. (retired pay), late Army Medical Service.
Temp. Hon. Lieut.-Col. Buchanan, G.S., M.D., Royal Army Medical Corps.
Major and Bt. Lieut.-Col. R. M. Carter, F.R.C.S., Indian Medical Service.
Col. W. Coates, C.B., V.D., Royal Army Medical Corps (T.F.), Reserve (retired).
Temp. Hon. Col. Sir J. Collie, M.D., Army Medical Service.
Temp.-Col. A. E. Garrod, C.M.G., M.D., F.R.S., Army Medical Service.
Col. Graham, M.D., C.B.
Major T. W. Griffith, M.D., Royal Army Medical Corps.
Col. J. Griffiths, M.D., F.R.C.S., T.D., Royal Army Medical Corps.
Surg.-Gen. F. J. Jencken, M.B., Army Medical Service.
Temp. Hon. Lieut.-Col. H. R. Kenwood, M.B., Royal Army Medical Corps (Major, Royal Army Medical Corps (T.F.)).
Temp. Lieut.-Col. J. C. C. Ledingham, M.B., Royal Army Medical Corps.
Col. C. H. Melville, M.B., Army Medical Service.
Col. C. P. Oliver, M.D., K.H.P., T.D., Army Medical Service.
Temp. Lieut.-Col. G. B. Price, M.D., Royal Army Medical Corps.
Temp. Hon. Lieut.-Col. J. Robertson, M.D., Royal Army Medical Corps.
Lieut.-Col. (Hon. Surg.-Col.) (Temp. Col.) W. M. Roocroft, V.D., Royal Army Medical Corps.
Col. and Hon. Surg.-Gen. M. W. Russell, C.B. (retired pay), late Army Medical Service.
Lieut.-Col. A. de C. Scanlan, Royal Army Medical Corps (retired pay) (Reserve of Officers).
Temp. Col. H. H. Tooth, C.M.G., M.D., Army Medical Service (Lieut.-Col., Royal Army Medical Corps (T.F.)).
Temp. Lieut.-Col. C. M. Wenyon, M.B., Royal Army Medical Corps.

ARMY MEDICAL SERVICE.

Col. T. H. J. C. Goodwin, C.M.G., D.S.O., to be Surgeon-General, vice Surg.-Gen. T. J. O'Donnell, C.B., D.S.O. (retired), January 11, 1918.

Surg.-Gen. T. H. J. C. Goodwin, C.M.G., D.S.O., to be Deputy Director-General, dated January 24, 1918.

Lieut.-Col. Horace S. Roch, D.S.O., to be Temp. Col. whilst employed as Assistant Director of Medical Services of a Division, dated December 28, 1917.

Lieut.-Col. John V. Forrest, C.M.G., M.B., to be Temporary Colonel whilst employed as Deputy Director of Medical Services, Lines of Communication, dated December 24, 1917.

Col. John J. Gerrard, C.B., M.B., to be Surgeon-General, dated January 27, 1918.

The undermentioned Lieutenant-Colonel to be Temporary Colonel :—

James S. Gallie, D.S.O., whilst employed as Deputy Director of Medical Services, Lines of Communication, dated January 1, 1918.

The undermentioned Lieutenant-Colonels to be Temporary Colonels whilst employed as Assistant Directors of Medical Services of a Division :—

James A. Hartigan, D.S.O., M.B., dated January 3, 1918.

Henry G. Martin, dated January 4, 1918.

The undermentioned Surgeon-Generals are placed on the retired list :—

Dated January 18, 1918.—Surg.-Gen. Thomas J. O'Donnell, C.B., D.S.O.

Dated January 27, 1918.—Surg.-Gen. Sir W. G. Macpherson, K.C.M.G., C.B., M.B.

Dated January 31, 1918.—Surg.-Gen. Robert Porter, C.B., M.B.

Dated February 7, 1918.—Surg.-Gen. John Chislett Culling, C.B.

Temp. Lieut.-Col. Francis Robert Hill, Royal Army Medical Corps, to be a Deputy Assistant Director-General, vice Lieut.-Col. F. McLennan, who has vacated the appointment, dated January 21, 1918.

ROYAL ARMY MEDICAL CORPS.

Lieut.-Col. Brian Watts, D.S.O., relinquishes the rank of Temp. Col. on re-posting, dated July 23, 1917.

Lieut.-Col. Lawrence Humphry, C.M.G., to be Temp. Col. whilst employed as Assistant Director of Medical Services of a Division, dated December 5, 1917.

The undermentioned relinquish the acting rank of Lieutenant-Colonel on re-posting :—

Dated November 19, 1917.—Major Richard F. Ellery.

Dated November 30, 1917.—Capt. John H. Gurley.

The undermentioned to be Acting Lieutenant-Colonels whilst specially employed, dated October 9, 1917 :—

Major William W. Browne ; Major Patrick Dwyer, M.C., M.B.

The undermentioned to be Acting Lieutenant-Colonels whilst in command of a Medical Unit :—

Dated November 19, 1917.—Major Richard C. Wilson, M.B.

Dated November 24, 1917.—Major John W. West, M.B.

Dated December 1, 1917.—Capt. Edmund W. Vaughan, M.B.

Dated December 4, 1917.—Major Charles G. Thomson, D.S.O.

The undermentioned Captains to be Majors, dated January 30, 1918 :—

Charles M. Drew, M.B.
Arthur G. Cummins, M.C., M.B.
Acting Lieut.-Col. Archibald S. Littlejohns, D.S.O.
William R. Galwey, M.C., M.B.
Robert G. Archibald, D.S.O., M.B.
Frank A. McCammon, M.C. M.B.
George De la Cour, M.B.
Acting Lieut.-Col. William Egan, D.S.O., M.B.
Brevet Major Robert G. H. Tate, M.D.
Alexander Dawson, M.B.
Augustus S. Williams, D.S.O.
Victor C. Honeybourne.
Clive T. Edmunds.
Valentine G. Johnson.
Acting Lieut.-Col. Charles R. M. Morris, D.S.O., M.B.
Acting Lieut.-Col. Richard E. V. Newman, M.C., M.B.
Ernest W. M. Paine.
Frederick D. G. Howell, D.S.O., M.C.
Temp. Major Patrick Sampson, D.S.O.
Brevet Major Marcus G. Dill, M.D.
John B. Grogan.
Acting Lieut.-Col. Edward M. O'Neill, D.S.O., M.B.
Acting Lieut.-Col. Georgie B. Edwards, D.S.O.
Acting Lieut.-Col. John W. L. Scott, D.S.O.
William C. Smales, D.S.O.
Arthur H. Bond.
Thomas C. C. Leslie.
Donald de C. O'Grady.
Lawrence G. Gibson.
Philip S. Stewart, M.B.
Timothy W. O. Sexton.
Acting Lieut.-Col. Thomas T. H. Robinson, M.B.

The undermentioned retain the acting rank of Lieutenant-Colonel whilst commanding a Medical Unit, August 16, 1917 :—

Dated August 16, 1917.—Major Ernest B. Knox, M.D.

Dated September 9, 1917.—Major Phillip J. Marett. (Substituted for the notification in the *Gazette* of December 6, 1917.)

The undermentioned Captains to be Acting Lieutenant-Colonels whilst in command of a Medical Unit :—

Dated November 17, 1917.—Francis Casement, D.S.O., M.B.

Dated December 3, 1917.—John G. Gill, M.C., M.B.

Capt. Arthur F. Heaton to be Major, dated November 27, 1917.

Major James F. Martin, C.M.G., M.B., to be Temporary Lieutenant-Colonel whilst employed as Assistant Director of Medical Services, dated December 30, 1917.

The undermentioned to be Acting Lieutenant-Colonels whilst in command of a Medical Unit:—

Dated December 9, 1917.—Capt. Frank A. McCammon, M.C., M.B.

Dated December 14, 1917.—Major Cuthbert G. Browne, D.S.O.

Dated December 23, 1917.—Capt. Cyril Helm, M.C.

The undermentioned Majors to be Lieutenant-Colonels, dated December 26, 1917:—

Brevet Lieut.-Col. C. E. P. Fowler. | G. S. Mansfield, M.B.
Brevet Lieut.-Col. H. A. Berryman.

Major Edward L. Moss, M.C., retains the acting rank of Lieutenant-Colonel whilst specially employed, dated December 29, 1917.

The undermentioned Lieutenants (Temp. Captains) to be Captains:—

Dated February 5, 1918.—Evan Davies, M.B.; Robert E. Barnsley, M.C.

Dated February 6, 1918.—Thomas J. Kelly, M.C., M.B.; Raymond J. Clausen, M.C., M.B.; Campbell McN. McCormack, M.C., M.B.

Dated February 7, 1918.—George D. Jameson; Duncan W. Pailthorpe, M.C.; St. John D. Buxton.

Dated February 8, 1918.—Ernest F. W. Grellier.

Dated February 9, 1918.—Stanley Arnott, M.B.; Thomas L. Fraser, M.B.

Dated February 10, 1918.—Lancelot G. Bourdillon, D.S.O., M.C.

Dated February 12, 1918.—Acting Lieut.-Col. Richard A. Preston, M.C., M.B.; Arthur B. Preston.

Dated February 13, 1918.—John Sainsbury, M.D.; Granville D. Robertson.

Dated February 15, 1918.—Hamish D. F. Brand, M.B.

Dated February 16, 1918.—Robert Ellis, M.C., M.B.; Francis G. A. Smyth; Joseph P. Little; Charles J. O'Reilly, M.C., M.B.

The undermentioned Majors relinquish the acting rank of Lieutenant-Colonels on re-posting:—

Dated October 30, 1917.—John H. Brunskill, D.S.O., M.B.

Dated November 17, 1917.—George H. J. Brown, D.S.O., M.B.

Dated December 12, 1917.—Benjamin H. V. Dunbar, D.S.O., M.D.

Major Arthur E. S. Irvine, D.S.O., retains the acting rank of Lieutenant-Colonel whilst in command of a Medical Unit, dated December 4, 1917.

The undermentioned to be Acting Lieutenant-Colonels whilst in command of a Medical Unit:—

Dated November 13, 1917.—Major James C. G. Carmichael, M.B.

Dated December 11, 1917.—Major Frank M. Parry, M.B.

Dated December 14, 1917.—Capt. Ernest D. Caddell, M.C., M.B.

Lieut. (Temp. Capt.) David C. Monro, M.B., to be Capt., dated February 17, 1918.

The undermentioned Lieutenants (Temporary Captains) to be Captains, dated February 18, 1918:—

William Foot, M.C., M.B.; Frederick C. K. Austin.

The undermentioned Lieutenants (Temporary Captains) to be Captains, dated February 22, 1918:—

A. E. Argo Galvin, M.B.; S. Crosse Spencer; W. Galloway Rudolf, M.B.

Lieut.-Col. Basil F. Wingate, D.S.O., to be Temporary Col. whilst employed as Assistant Director of Medical Services of a Division, dated January 5, 1918.

Major (Acting Lieut.-Col.) Norman E. Dunkerton relinquishes his acting rank on re-posting, dated January 14, 1918.

Major Henry A. Bransbury, D.S.O., to be Acting Lieutenant-Colonel whilst in command of a Medical Unit, dated October 4, 1917.

ROYAL ARMY MEDICAL CORPS FUND.

PROCEEDINGS OF A COMMITTEE MEETING HELD AT ADASTRAL HOUSE, WAR OFFICE, ON FEBRUARY 27, 1918.

Present:

Surg.-Gen. Sir W. Donovan, K.C.B., one of the Trustees, in the chair.
Surg.-Gen. Sir D. Bruce, K.C.B.
Col. Sir J. Magill, K.C.B.
Col. C. R. Tyrrel, C.B.
Lieut.-Col. A. B. Cottell.
Capt. H. H. Blake, Band President.

(1) The minutes of the last meeting held on October 2, 1917, were read and confirmed.

(2) The Secretary reported the separation of the accounts into two Branches, viz., Officers' Branch, and General Relief Branch, and also the present cash balances of the two branches, and

it was decided to invest £800 from the Officers' Branch and £300 from the Relief Branch in National War Bonds, the series to be decided after consultation with Messrs. Holt and Co.

(3) The accounts for the year 1917 were examined and approved subject to audit.

(4) The question of the payment of £2 5s. 6d., binding expenses connected with the Commemoration Service for the First Seven Divisions, held at the Albert Hall on December 15, was considered, and it was decided to pay this amount from office expenses.

(5) The question was considered of payment of £12 12s., expenses incurred by Capt. J. T. Clapham in connexion with "Press Cuttings" relating to the Royal Army Medical Corps, which have appeared during the present War, and which were collected by him in accordance with a suggestion made by Surg.-Gen. M. Russell, at that time Deputy Director-General.

Payment was approved with a cordial vote of thanks to Capt. Clapham for all the trouble he had taken in the matter. Capt. Clapham, who was present at the meeting, was asked to communicate with the historian of the Medical History of the War as to the disposal of the cuttings already collected, and as to future action, and to report result at the next meeting.

(6) The Secretary reported five grants from the General Relief Branch to urgent cases amounting to £26 since the last meeting. Approved.

Also the return of a grant of £6 made to the widow of the late Cpl. Luker, resident at Gibraltar, voted at the last meeting, on the grounds that it was not then required; and the Secretary was directed to write to O.C.R.A.M.C., Gibraltar, asking him to communicate again should assistance in the case be required at any future time.

(7) The Secretary reported receipt of a Bearer Bond five per cent National War Bonds 1927 for £200 from R.A.M.C. depot, Blackpool, for the General Relief Branch. This has been invested in the names of the Trustees.

(8) An application was considered from the R.A.M.C. Comforts Fund for further assistance on account of the recent large increase in the number of prisoners of war of the Corps, and it was decided to grant £25 from the General Relief Branch.

(9) The Secretary requested authority to purchase the telephone which had been installed by the Auxiliary R.A.M.C. Fund at a cost of £4, and which was now left behind on the removal of that Fund to another office. Approved.

(10) The purchase of additional office furniture was approved, not exceeding £5, one-third being chargeable to each of the Branches of this Fund and the remaining third to the R.A.M.C. Benevolent Society.

(11) The Secretary reported that the office expenses for the year 1917 amounted to £186 4s. 11d., to be divided into three equal shares between the two Branches of this Fund and the R.A.M.C. Benevolent Society in accordance with the decision of the Annual General Meeting held on June 11, 1917, and it was decided to continue the present method of book-keeping in future, subject to the approval of the auditor.

(12) The President of the Band Committee presented the accounts for the Band, September to December, 1917, and applied for a grant of £100. Approved.

He also submitted an application for an increase of salary to the Band Master of £1 a month and to the Band Serjeant of 10s. a month, on account of the great increase of cost of living—such increase to be regarded as temporary and to be described as a "War Bonus."

A grant of £20 for this purpose was approved.

(13) The Secretary reported that no book existed showing the formation, constitution and objects of the Funds, which could be utilized for the information of all subscribers and as a permanent record; and he was authorized to prepare a rough draft of such a book with approximate cost of printing, and to make a report at the next meeting.

ROYAL ARMY MEDICAL CORPS OFFICERS' BENEVOLENT SOCIETY.

PROCEEDINGS OF A COMMITTEE MEETING HELD AT ADASTRAL HOUSE, WAR OFFICE, ON FEBRUARY 27, 1918.

Present:

Surg.-Gen. Sir W. Donovan, K.C.B., one of the Trustees, in the Chair.
Surg.-Gen. Sir D. Bruce, K.C.B.
Lieut.-Col. A. B. Cottell.
Capt. J. T. Clapham.

(1) The Minutes of the last meeting held on October 2, 1917, were read and confirmed.

(2) The accounts for the year 1917 were examined and approved subject to audit.

(3) The Secretary was instructed to make inquiries as to the present value of the Railway Securities, and as to the advisability of the Society continuing to hold them.

(4) The Secretary reported new members joining and the present cash balance of the Fund, and was directed to make inquiries as to the best method of circularizing officers on the active list, with a view of making the existence of the Society more widely known, and obtaining a larger number of subscribers. The necessary expenditure on printing, postage, etc., was approved.

(5) Applications from orphans which had been received were considered and small grants made under Rule 24 were approved to be made.

(6) The question of sending out application forms to orphans to whom grants had been issued last year was considered, and it was decided to issue these forms accompanied in each case by a letter stating that this action was not to be regarded as a guarantee that any grant would be made.

(7) The Secretary reported two grants of £10 each which had been made to applicants in very urgent cases since the last meeting under Rule 31. Approved.

(8) The Secretary reported that the office expenses for the last year in accordance with the decision of the last Annual General Meeting had amounted to £62 1s. 8d., viz., one third of the total expenditure of the Royal Army Medical Corps Fund (two branches) and this Society; and it was agreed that the present method of book-keeping should be continued subject to the approval of the auditor.

(9) The Secretary reported that Messrs. Sir Charles McGrigor, Bart., and Co., had recovered the Income Tax for the year 1917 free of charge, and that he had written on behalf of the Committee to Sir Charles McGrigor, Bart., and Co., expressing his cordial thanks for their kind assistance.

(10) A grant for the purchase of additional office furniture was approved, one third being payable by this Society, the total not to exceed £5.

ROYAL ARMY MEDICAL CORPS COMFORTS FUND.

The Honorary Secretary's Report for 1917.

The first part of 1917 we were fortunate enough to have no men of the Royal Army Medical Corps prisoners of war in Germany. Working under the rules of the Central Prisoners of War Committee we have sent since the beginning of January, three parcels of food a fortnight to all men of the Royal Army Medical Corps who are prisoners of war in Germany.

According to regulations these parcels contain 10 pounds weight of food, and are of an average cost of 9s. each; some of the contents are: tinned meats of various kinds, fish, cocoa, cheese, milk, vegetables, fruit, jam, syrup, biscuits, butter, margarine, dripping, puddings, condiments, etc., and packets of flour, sugar, tea, quaker oats, cornflour, soup squares, and many other useful articles of food. A fortnightly supply of tobacco and cigarettes is sent, out of Bond, direct to each man. Bread also is sent each week from Copenhagen to the men in Germany. Clothing parcels are sent out every six months. Altogether about 1,000 parcels of food and clothing (exclusive of tobacco and bread) have been sent out from our packing rooms during 1917. Twice in the year parcels to Turkey have been stopped; during these periods we have sent postal orders for 5s. a week to our prisoners of war, the money reached the men fairly satisfactorily.

As parcels do not by any means, all arrive in Turkey, the Committee decided that only one parcel and 10s. in money in lieu of the other parcels should be sent each fortnight. This course has been followed these last few months, the money being sent through the Comite Internationale de la croix rouge in Geneva. Sufficient time has not elapsed for us to judge the result of this experiment. As the number of prisoners of war has considerably increased, and the difficulties in procuring foods become greater daily, the cost of the parcels increases correspondingly. The Committee hope they will be given sufficient support to enable them to continue caring for the men of the Corps during the coming year.

All Royal Army Medical Corps Men, Regulars, New Army, Special Reserve, and Territorial, are under the care of the Royal Army Medical Corps Comforts Fund. Sometimes Territorial County Associations wish to look after and provide for all men belonging to their county Units. In these cases we transfer the men to the Territorial Prisoners of War Fund for all parcels, excepting bread, which is in all cases invariably supplied by us, at a cost of 1s. 10½d. per week per man.

Owing to our Prisoners of War work having so greatly increased, we have not been able to send as many comforts as formerly to the Medical Units overseas—altogether, only about 150 bales, each of fifty-five pounds weight, have been dispatched to Salonika, Mesopotamia and Egypt, and a few dozen consignments of games to Units in France who especially asked to be so supplied.

Lieut.-Col. E. M. Wilson, who has kindly acted as Honorary Treasurer since Lieut.-Col. Harris's death, will submit the Balance Sheet for publication in the Journal of the Royal Army Medical Corps.

The work depots in Edinburgh and Trenock still help splendidly in supplying comforts, and another has recently been started in Blackpool with the same object. The working party which was organized last December meets once a week, and has helped splendidly with making large numbers of shirts, socks, etc.: all materials have been supplied by donations from the ladies themselves.

Lady Sloggett and the Central Ladies Committee for Royal Army Medical Corps Comforts

ROYAL ARMY MEDICAL CORPS COMFORTS FUND.

Statement of Accounts for 1917.

Receipts.	£	s.	d.
Balance in hand, December 31, 1916	60	14	9
Grants and Donations, 1917	1,280	3	9
	£1,340	18	6

Expenditure.	£	s.	d.
Gamage, Ltd.	38	19	2
Army and Navy Stores	138	18	9
Derry and Toms, Ltd.	52	7	9
Empire Service	141	12	1
G. W. Dray and Son	6	18	6
Drayton Paper Mills	9	9	6
Watford Manufacturing Company	5	14	0
N. Hants Printing Company	9	1	6
G. W. Railway Company	1	5	5
Mrs. Morgan: Imprest Account	38	0	0
Lipton, Ltd.	11	7	0
Messrs. J. H. Swainston	131	16	11
Nestle's Milk Company	30	9	2
Messrs. G. F. Wyatt	11	2	4
Walkers' Tobacco Market	17	19	7
Liverpool Courier	1	2	6
Bankers' Charges	1	5	5
Stamps	1	0	0
Prisoners of War Comforts, &c.	74	11	9
	£723	1	4
Cheques not yet paid in	6	0	0
	£717	1	4
Balance as per Pass Book	623	17	2
	£1,340	18	6

In addition Mrs. Morgan has in hand £2 8s. 9d. Petty Cash.

February 22, 1918.

Examined and found correct,
(*Signed*) EDMOND T. GANN.

wish to thank all who have so kindly helped them in the past, and they hope for a continuance of their support so as to enable them to maintain their work for the prisoners of war.

All money donations should be sent to—

The Honorary Secretary,
R.A.M.C. Comforts Fund,
R.A.M.C. College,
Grosvenor Road, London, S.W. 1.

(*Signed*) ELEANOR MORGAN, *Hon. Secretary.*
December 31, 1917.

ARMY MEDICAL OFFICERS' WIDOWS AND ORPHANS FUND.

SUMMARY OF THE PROCEEDINGS OF THE QUARTERLY MEETING HELD AT THE ROYAL ARMY MEDICAL COLLEGE, ON WEDNESDAY, JANUARY 23, 1918.

Present:—
Dep. Surg.-Gen. W. G. Don, Vice-President, in the Chair.
Lieut.-Col. G. S. Mansfield.
The Secretary.

The Minutes of the previous meeting were read and confirmed.

Lieut. (Temp. Capt.) A. E. Richmond was admitted a married member of the Society at an annual subscription of £12 10s. 8d., together with an extra war charge of £26 5s. per annum.

The death was reported of Lieut.-Col. D. B. Miller, an unmarried member, and of Capt. W. F. Bailey, a married member. The resignation was reported of Lieut.-Col. W. M. Herman, an unmarried member.

A certificate was submitted from the Actuary that the Stock Exchange Securities held by the Society were Trustee Securities on December 31, 1917.

The Secretary reported that £3,000 five per cent National War Bonds had been taken up in December, 1917, out of cash balances, as advised by Sir James McGrigor and Mr. Andras.

A letter from Lieut.-Col. R. J. L. Fayle, D.S.O., was read in which he regretted that his duties did not allow his attendance at meetings of the Committee. The Secretary was directed to make inquiry as to members available to fill vacancies on the Committee.

Payment of the Actuary's fee (£10 10s.) for the year 1917 was sanctioned, as was that of the Secretary's salary for the past quarter.

3, *Homefield Road,*
Wimbledon, S.W.

J. T. CLAPHAM, *Captain,*
Secretary.

Note.—This Fund provides annuities of £50 a year (together with any additional benefits which may be available from distribution of surplus which at present, in the majority of cases, amount to a bonus of £200 to the widow) to the widows of subscribers and to their children under 21 years of age. The annual subscription varies according to the ages of husband and wife: e.g. in the case of a husband aged 30, and wife aged 25, it would amount to £14 18s. 6d.: where husband and wife were both aged 28 it would be £12 19s. 11d. At the outbreak of war an additional war charge of 50 guineas per annum was made, and eligibility for membership was limited to officers on the strength of the Corps on that date.

The death rate amongst officers of the Corps having been lower in the later stages of the war than was expected the Committee have been able to reduce the extra war charge to one of 25 guineas per annum, in addition to the normal annual subscription according to scale. It has also been resolved that officers gazetted to permanent commissions in the Corps on January 1, 1917, and up to May 22, 1917, shall be eligible for membership on the above terms. The cases of those who may be gazetted later will be considered as they arise.

The Secretary will be glad to give any further information as to details.

BIRTHS.

SKRIMSHIRE.—On January 14, 1918, at Bangalore, South India, the wife of Captain F. R. B. Skrimshire, R.A.M.C., of a son.

ELLIOT.—On February 17, 1918, at Southsea, Hants, the wife of Captain E. J. Elliot, R.A.M.C., of a daughter.

EXCHANGES, &c.

The charge for inserting Notices respecting Exchanges in the Royal Army Medical Corps is 5/- for not more than five lines, which should be forwarded by Cheque or P.O.O., with the notice, to Messrs. G. STREET and CO., Ltd., 8, Serle Street, London, W.C., not later than the 22nd of the month.

A free issue of twenty-five reprints will be made to contributors of Original Communications, and of twenty-five excerpts of Lectures, Travels and Proceedings of the United Services Medical Society.

Any demand for reprints, additional to the above, or for excerpts, must be forwarded at the time of submission of the article for publication, and will be charged for at the following rates, and additional copies at proportionate rates:—

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12	4	0 2 9	0 1 2	4	3	1	1	3 10	0 9
	8	0 5 0	0 2 3						
	16	0 8 3	0 3 11						
25	4	0 3 4	0 1 5	4	10	1	6	4 4	0 11
	8	0 6 0	0 2 9						
	16	0 10 6	0 5 0						
50	4	0 4 6	0 1 10	6	0	2	1	4 10	1 2
	8	0 7 6	0 3 6						
	16	0 13 3	0 5 10						
100	4	0 6 0	0 3 1	7	10	3	11	6 7	2 5
	8	0 10 0	0 4 10						
	16	0 18 6	0 7 6						
200	4	0 9 6	0 4 5	10	10	7	6	9 0	4 10
	8	0 15 0	0 6 7						
	16	1 6 0	0 9 8						

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The back outside cover is not available for advertisements.

Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

All such Communications or Articles accepted and published in the "Journal of the Royal Army Medical Corps" will (unless the Author notified at the time of submission that he reserves the copyright of the Article to himself) become the property of the Library and Journal Committee, who will exercise full copyright powers concerning such Articles.

Matter intended for the Corps News should reach the Editor not later than the 15th of each month for the following month's issue. Notices of Births, Marriages, and Deaths are inserted free of charge to subscribers and members of the Corps. All these communications should be written upon one side of the paper only; they should by preference be type-written; but, if not, all proper names should be written in capital letters (or printed) to avoid mistakes, and be addressed: The Editor, "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS," 324, Adastral House, Victoria Embankment, E.C. 4.

The following publications have been received:—

British: The Practitioner, The Medical Journal of Australia, The Royal Engineers' Journal, The Hospital, Tropical Diseases Bulletin, Guy's Hospital Gazette, Transactions of the Society of Tropical Medicine and Hygiene, The Medical Press and Circular, The Saturday Review, Edinburgh Medical Journal, St. Bartholomew's Hospital Journal, Annals of Tropical Medicine and Parasitology, The Veterinary Review.

Foreign: Office International d'Hygiène Publique, Annali di Medicina Navale e Coloniale, The Military Surgeon, Bulletin of the Johns Hopkins Hospital, Bulletin de la Société de Pathologie Exotique, Archives Médicales Belges, Memorias do Instituto Oswaldo Cruz, United States Public Health Service.

Communications have been received from Lieut.-Col. J. Stony Archer.

MANAGER'S NOTICES.

The JOURNAL OF THE ROYAL ARMY MEDICAL CORPS is published monthly, six months constituting one volume, a volume commencing on 1st July and 1st January of each year.

The Annual Subscription is £1 (which includes postage), and should commence either on 1st July or 1st January; but if a subscriber wishes to commence at any other month he may do so by paying for the odd months between 1st July and 1st January at the rate of 1s. 8d. (one shilling and eightpence) per copy. (All subscriptions are payable in advance.)

Single copies can be obtained at the rate of 2s. per copy.

The Corps News is also issued separately from the Journal, and can be subscribed for at the rate of 2s. (two shillings) per annum, including postage. Subscriptions should commence from 1st July each year; but if intending subscribers wish to commence from any other month, they may do so by paying for the odd months at the rate of 2d. per copy. (All subscriptions are payable in advance.)

Officers of the Royal Army Medical Corps possessing Diplomas in Public Health, etc., are kindly requested to register their special qualifications at the War Office. Letters of complaint are frequently received from officers stating that their special qualifications have not been shown in the Distribution List which is published as a supplement to the Journal in April and October of each year. As, however, the particulars of this list are supplied from official sources, officers are reminded that unless the possession of Diplomas, etc., has been registered at the War Office, no entry of such qualifications can be recorded in the Distribution List.

Letters notifying change of address should be sent to the Hon. Manager, "Journal of the Royal Army Medical Corps," 25, Adastral House, Victoria Embankment, E.C. 4, and must reach there not later than the 20th of each month for the alteration to be made for the following month's issue.

It is requested that all Cheques or Postal Orders for Subscriptions to the Journal, Corps News, Reprints, etc., be crossed "Holt & Co.," and made payable to the "Hon. Manager, Journal R.A.M.C.," and not to any individual personally.

All communications for the Hon. Manager regarding subscriptions, etc., should be addressed to

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